DRAFT Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys and Coast Region

U.S. Army Corps of Engineers

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Contents

Preface

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual. It was developed by the U.S. Army Engineer Research and Development Center (ERDC) at the request of Headquarters, U.S. Army Corps of Engineers (USACE), with funding provided through the Wetlands Regulatory Assistance Program (WRAP).

This document was developed in cooperation with the Western Mountains, Valleys and Coast Regional Working Group, whose members contributed their time and expertise to the project over a period of many months. Working Group meetings were held in Portland, OR, on 15-17 November 2005; and Denver, CO, on 22-23 March 2006. Members of the Regional Working Group and contributors to this document were:

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Technical reviews were provided by the following members of the National Advisory Team for Wetland Delineation: Steve Eggers, U.S. Army Engineer (USAE) District, St. Paul, MN; Karl Hipple, NRCS National Soil Survey Center, Lincoln, NE; Dan Martel, USAE District, San Francisco, CA; Jennifer McCarthy, NRCS, Washington, DC; Norman Melvin, NRCS Central National Technology Support Center, Fort Worth, TX; Paul Minkin, USAE District, New England, Concord, MA; Ralph Thomas Rogers, EPA, Seattle, WA; Stuart Santos, USAE District, Jacksonville, FL; Ralph Spagnolo, EPA, Philadelphia, PA; Ralph Tiner, U.S. Fish and Wildlife Service, Hadley, MA; P. Michael Whited, NRCS, Holden, MA; and James Wood, USAE District, Albuquerque, NM. In addition, portions of this Regional Supplement that address soils issues were reviewed and endorsed by the National Technical Committee for Hydric Soils (Karl Hipple, chair).

Independent peer reviews were performed in accordance with Office of Management and Budget guidelines. The peer-review team consisted of ________________________.

Technical editors for this Regional Supplement were Dr. James S. Wakeley, Mr. Robert W. Lichvar, and Mr. Chris V. Noble, ERDC. Ms. Katherine Trott was the project proponent and coordinator at Headquarters, USACE. During the conduct of this work, Dr. Morris Mauney was Chief of the Wetlands and Coastal Ecology Branch; Dr. David Tazik was Chief, Ecosystem Evaluation and Engineering Division; and Dr. Elizabeth Fleming was Director, EL. Dr. James Houston was Director and COL Richard Jenkins was Commander of ERDC.

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1 Introduction

Purpose and Use of this Regional Supplement

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual (hereafter called the Corps Manual). The Corps Manual provides technical guidance and procedures, from a national perspective, for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act (33 U.S.C. 1344). According to the Corps Manual, identification of wetlands is based on a three-factor approach involving indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. This Regional Supplement presents wetland indicators, delineation guidance, and other information that is specific to the Western Mountains, Valleys and Coast Region.

This Regional Supplement is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. Regional differences in climate, geology, soils, hydrology, plant and animal communities, and other factors are important to the identification and functioning of wetlands. These differences cannot be considered adequately in a single national manual. The development of this supplement follows National Academy of Sciences recommendations to increase the regional sensitivity of wetland-delineation methods (National Research Council 1995). The intent of this supplement is to bring the Corps Manual up to date with current knowledge and practice in the region and not to change wetland boundaries. The procedures given in the Corps Manual, in combination with wetland indicators provided in this supplement, can be used to identify wetlands for a number of purposes, including resource inventories, management plans, and regulatory programs. The determination that a wetland is subject to regulatory jurisdiction under Section 404 must be made independently of procedures described in this supplement.

This Regional Supplement is designed for use with the current version of the Corps Manual (Environmental Laboratory 1987) and all subsequent versions. Where differences in the two documents occur, this Regional Supplement takes precedence over the Corps Manual for applications in the Western Mountains, Valleys and Coast Region. Table 1 identifies specific sections of the Corps Manual that are replaced by this supplement. Other guidance and procedures given in this supplement and not listed in Table 1 are intended to augment the Corps Manual but not necessarily to replace it. Corps of Engineers Districts have final authority over the use and interpretation of the Corps Manual and this supplement in the Western Mountains, Valleys and Coast Region.

Indicators and procedures given in this Supplement are designed to identify wetlands as defined jointly by the Corps of Engineers (33 CFR 328.3) and Environmental Protection Agency (40 CFR 230.3). Wetlands are a subset of the “waters of the United States” that may be subject to regulation under Section 404. One key feature of the definition of wetlands is that, under normal circumstances, they support “a prevalence of vegetation typically adapted for life in saturated soil conditions.” Many waters of the United States are unvegetated and thus are excluded from the Corps/EPA definition of wetlands, although they may still be subject to Clean Water Act regulation. Other potential waters of the United States in the Western Mountains, Valleys and Coast Region include, but are not limited to, tidal flats and shorelines along the coast and in estuaries, lakes, rivers, seasonal ponds, and intermittent, ephemeral, and perennial stream channels. Delineation of these waters is based on the high tide line, the "ordinary high water mark" (33 CFR 328.3), or other criteria and is beyond the scope of this Regional Supplement.

Amendments to this document will be issued periodically in response to new scientific information and user comments. Between published versions, Headquarters, U.S. Army Corps of Engineers, may provide updates to this document and any other supplemental information used to make wetland determinations under Section 404. Wetland delineators should use the most recent approved versions of this document and supplemental information. See the Corps of Engineers Headquarters regulatory web site for information and updates (http://www.usace.army.mil/inet/functions/cw/cecwo/reg/). The Corps of Engineers has established an interagency National Advisory Team for Wetland Delineation whose role is to review new data and make recommendations for needed changes in wetland-delineation procedures to Headquarters, U.S. Army Corps of Engineers. Items for consideration by the Team, including full documentation and supporting data, should be submitted to:

National Advisory Team for Wetland Delineation
Regulatory Branch (Attn: CECW-CO)
U.S. Army Corps of Engineers
441 G Street, N.W.
Washington, DC 20314-1000

Table 1
Sections of the Corps Manual replaced by this Regional Supplement for applications in the Western Mountains, Valleys and Coast Region

Item	Replaced Portions of the Corps Manual (Environmental Laboratory 1987)	Replacement Guidance (this Supplement)
Hydrophytic Vegetation Indicators	Paragraph 35, all subparts, and all references to specific indicators in Part IV.	Chapter 2
Hydric Soil Indicators	Paragraphs 44 and 45, all subparts, and all references to specific indicators in Part IV.	Chapter 3
Wetland Hydrology Indicators	Paragraph 49(b), all subparts, and all references to specific indicators in Part IV.	Chapter 4
Growing Season Definition	Glossary	Chapter 4, Growing Season; Glossary
Hydrology Standard for Highly Disturbed or Problematic Wetland Situations	Paragraph 48, including Table 5 and the accompanying User Note in the online version of the Manual	Chapter 5, Wetlands that Periodically Lack Indicators of Wetland Hydrology, Procedure item 3(h)

Applicable Region and Subregions

This supplement is applicable to the Western Mountains, Valleys and Coast Region, which consists of portions of 12 states, including Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming (Figure 1). The region contains the major western mountain ranges – the Cascade Mountains, Sierra Nevada Mountains, and Rocky Mountains – and other scattered mountain ranges where the vegetation is dominated mainly by coniferous forests at lower elevations and alpine tundra at the highest elevations. The region also embraces the numerous interspersed valleys, meadows, high plateaus, and parks within the mountainous areas, which often support grasses, forbs, or shrubs, and includes the Coast Ranges, rain forests, and coastal zone from northern California to the Canadian border. About half of the region is in Federal ownership, mostly in national forests.

The Western Mountains, Valleys and Coast Region surrounds and is interspersed with the Arid West Region (U.S. Army Corps of Engineers 2006) but generally receives more abundant rainfall and/or snow, has lower average temperatures, higher humidity, and lower evapotranspiration rates. Streams in the region tend to be perennial, whereas those in the Arid West are more often intermittent or ephemeral. Many of the streams and rivers that flow into and through the Arid West have their headwaters in the Western Mountains, Valleys and Coast Region.

The approximate spatial extent of the Western Mountains, Valleys and Coast Region is shown in Figure 1. This map is based mainly on a combination of Land Resource Regions (LRR) A and E recognized by the U. S. Department of Agriculture (USDA Natural Resources Conservation Service 2006a). Subregion boundaries used for certain indicators in this supplement correspond to LRRs. In addition, the region includes the following portions of LRR B, C, D and G (Figure 1):

- Sierra Nevada Mountains (Major Land Resource Area (MLRA) 22A)
- Southern Cascade Mountains (MLRA 22B)
- Arizona and New Mexico Mountains (MLRA 39)
- Black Hills (MLRA 62)
- Other mountain ranges scattered throughout the West that support mainly coniferous forests on the slopes and open coniferous woodlands, shrublands, meadows, and hardwood riparian woodlands in the valleys, down to the lower elevational limit of the ponderosa pine (*Pinus ponderosa*) zone or its local equivalent (Table 2).

Areas dominated by pinyon/juniper (e.g., *Pinus monophylla* or *P. edulis* / *Juniperus* spp.) woodlands are excluded from this region and included within the Arid West Region (U.S. Army Corps of Engineers 2006).

Most of the wetland indicators presented in this supplement are applicable throughout the entire Western Mountains, Valleys and Coast Region. However, some indicators are restricted to specific subregions (i.e., LRR) or smaller areas (i.e., MLRA).

The decision to use the Western Mountains, Valleys and Coast Regional Supplement or the Arid West Regional Supplement on a particular field site should be based on landscape and site conditions, and not solely on map location. Figure 1 is highly generalized and does not indicate many of the smaller mountain ranges where the Western Mountains, Valleys and Coast supplement would be applicable. Furthermore, there are arid environments within the highlighted areas in Figure 1 where the Arid West Regional Supplement would be appropriate. Table 2 provides guidance for selection of the appropriate Regional Supplement based on site conditions.

Region and subregion boundaries are depicted in Figure 1 as sharp lines. However, climatic conditions and the physical and biological characteristics of landscapes do not change abruptly at the boundaries. In reality, regions and subregions often grade into one another in broad transition zones that may be tens or hundreds of miles wide. The lists of wetland indicators presented in these Regional Supplements may differ between adjoining regions or subregions. In transitional areas, the investigator must use experience and good judgment to select the supplement and indicators that are appropriate to the site based on its physical and biological characteristics. Wetland boundaries are not likely to differ between two supplements in transitional areas, but one supplement may provide more detailed treatment of certain problem situations encountered on the site. If in doubt about which supplement to use in a particular area, contact the appropriate Corps of Engineers District Regulatory Office for guidance. Contact information for District regulatory offices is available at the Corps Headquarters web site (http://www.usace.army.mil/inet/functions/cw/cecwo/reg/district.htm).

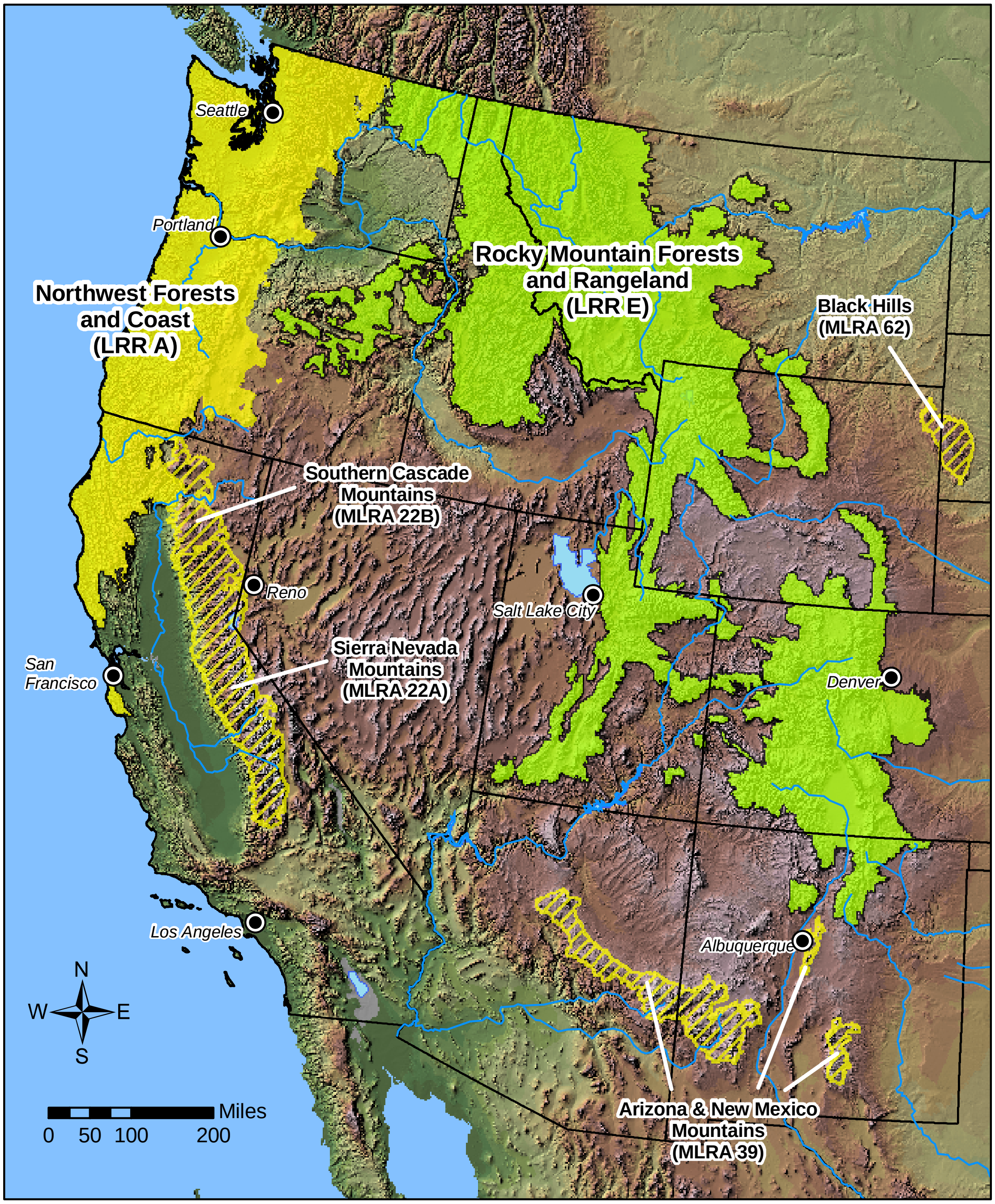

Figure 1. Generalized map of the Western Mountains, Valleys and Coast Region. The region consists mainly of USDA Land Resource Regions (LRR) A and E, but also includes the Sierra Nevada Mountains (MLRA 22A), Southern Cascade Mountains (MLRA 22B), Arizona and New Mexico Mountains (MLRA 39), Black Hills (MLRA 62), and other mountainous areas not shown that are dominated by coniferous forests on the slopes and coniferous woodlands, hardwood riparian woodlands, shrublands, or meadows in the valleys, down to the lower limit of the ponderosa pine zone. See text for details.

Table 2
Comparison of site characteristics for application of the Arid West Regional Supplement or the Western Mountains, Valleys and Coast Regional Supplement

Site Characteristics	Arid West Regional Supplement	Western Mountains, Valleys and Coast Regional Supplement
Climate	Generally hot and dry with a long summer dry season. Average annual precipitation mostly <15 in. (380 mm) except along the coast. Most precipitation falls as rain.	Cooler and more humid, with a shorter dry season. Average annual precipitation mostly >20 in. (500 mm). Much of the annual precipitation falls as snow, particularly at higher elevations.
Vegetation	Little or no forest cover at the same elevation as the site and, if present, usually dominated by pinyon pine (e.g., *P. monophylla* or *P. edulis*), junipers (*Juniperus*), cottonwoods (e.g., *Populus fremontii*), willows (*Salix*), or hardwoods (e.g., *Quercus, Platanus*). Landscape mostly dominated by grasses and shrubs (e.g., sagebrush (*Artemisia*), rabbitbrush (*Chrysothamnus*), bitterbrush (*Purshia*), and creosote bush (*Larrea*)). Halophytes (e.g., *Allenrolfea, Salicornia, Distichlis*) present in saline areas.	Forests at comparable elevations in the local area dominated by conifers (e.g., spruce (*Picea),* fir *(Abies),* hemlock *(Tsuga),* Douglas-fir *(Pseudotsuga),* coast redwood (*Sequoia*), or pine *(Pinus)* except pinyon) or aspen (*Populus tremuloides*). West of the Cascades, Oregon ash (*Fraxinus latifolia*) and bigleaf maple (*Acer macrophyllum*) often dominate. Open areas generally dominated by grasses, sedges, shrubs (e.g., willows or alders (*Alnus*)), or alpine tundra.
Soils	Mostly dry, poorly developed, low in organic matter content, and high in carbonates. Soils sometimes highly alkaline. Surface salt crusts and efflorescences common in low areas.	Generally better developed, higher in organic matter content, and low in carbonates. Surface salt features are less common except in geothermal areas.
Hydrology	Drainage basins often lacking outlets. Temporary ponds (often saline), salt lakes, and ephemeral streams predominate. Water tables often perched. Major streams and rivers flow through but have headwaters outside the Arid West.	Streams and rivers often perennial. Open drainages with many natural, freshwater lakes. Water tables often continuous with deeper groundwater. Region serves as the headwaters of the major streams and rivers of the western United States.

Physical and Biological Characteristics of the Region

The Western Mountains, Valleys and Coast Region consists of steep, rugged mountains, high plateaus, gently sloping valleys, and a narrow coastal plain. Due to rugged topography, climatic conditions are highly variable across the region. The north-south orientation of the major mountain ranges forms barriers to the prevailing westerly winds, producing more abundant rainfall on west-facing slopes and rain-shadow effects on east-facing slopes and in interior valleys. Average annual precipitation ranges from more than 250 in. (6,350 mm) in the Olympic Mountains of Washington to 15 in. (380 mm) or less in the drier valleys and east-facing slopes of the Cascade Range and southern Rocky Mountains. Winters throughout the region tend to be long and cold, except near the ocean and in valleys west of the Cascades. The frost-free period is less than 70 days in the high mountains, but approaches 365 days on the coast (Bailey 1995, USDA Natural Resources Conservation Service 2006a).

This topographic and climatic diversity is reflected in very high vegetation diversity. Mountain slopes throughout the region generally are forested, but the dominant tree species change with location, elevation, and aspect. Other vegetation types include alpine tundra, mountain meadows, valley grasslands, shrublands, and hardwood riparian systems. The region is divided into two subregions, corresponding to Land Resource Regions A and E, plus other scattered mountain ranges that support predominantly coniferous forest vegetation (Figure 1). Important characteristics of each subregion and other applicable areas are described briefly below. Further details can be found in Bailey (1995) and USDA Natural Resources Conservation Service (2006a).

Northwest Forests and Coast (LRR A)

This subregion contains the northwest Coast Ranges, Cascade Mountains, Willamette Valley, Puget Sound, and the coastal plain, bays, and estuaries bordering the Pacific Ocean (Figure 1). Average annual temperature is 45 to 55 ºF (7 to 13 ºC) and average annual rainfall is 45 to 60 in. (1,145 to 1,525 mm) across much of the subregion, although the Willamette / Puget lowlands and eastern slope of the Cascades are drier (USDA Natural Resources Conservation Service 2006a). The subregion extends from sea level to roughly 5,000 ft (1,500 m) in elevation in the Coast Ranges and generally 8,000 to 9,000 ft (2,400 to 2,700 m) in the Cascades. Scattered volcanic peaks punctuate the Cascade range. The highest, Mount Rainier, rises more than 14,000 ft (4,300 m) (Bailey 1995).

Important tree species throughout the subregion include Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), grand fir (*Abies grandis*), silver fir (*A. amabilis*), and Sitka spruce (*Picea sitchensis*). At higher elevations, mountain hemlock (*T. mertensiana*), subalpine fir (*A. lasiocarpa*), and whitebark pine (*Pinus albicaulis*) are common. In the fog belt of coastal California, the coast redwood (*Sequoia sempervirens*) is common, and ponderosa pine dominates the drier eastern slope of the Cascade Mountains. Bigleaf maple (*Acer macrophyllum*), Oregon ash (*Fraxinus latifolia*), and other hardwood species are common in the Willamette / Puget lowlands (Bailey 1995). Prairie and savanna ecosystems are also present in the lowlands, although many have been converted to agriculture.

Rocky Mountain Forests and Rangeland (LRR E)

This subregion consists of the Rocky Mountains and associated mountain ranges, plateaus, parks, and valleys from New Mexico to the Canadian border (Figure 1). The mountains are rugged and glaciated, rising up to 14,000 ft (4,300 m) in the southern part of the range. Mountain slopes throughout the subregion tend to be forested, with valleys dominated by shrubs and grasses (USDA Natural Resources Conservation Service 2006a). Average annual temperature ranges from 32 to 50 ºF (0 to 10 ºC) and average annual precipitation from less than 10 in. (255 mm) in the drier valleys to more than 40 in. (1,020 mm) in the mountains (Bailey 1995, USDA Natural Resources Conservation Service 2006a).

Vegetation across the subregion is distributed in altitudinal zones modified by the effects of latitude, exposure, and prevailing winds (Bailey 1995). The highest elevations are treeless and dominated by alpine tundra. Below that, the subalpine zone in many areas is dominated by Engelmann spruce (*Picea engelmannii*) and subalpine fir. Below the subalpine zone, the montane zone in the southern Rocky Mountains supports mainly Douglas-fir on the higher and/or moister sites and ponderosa pine on the lower and/or drier sites. Lodge-pole pine (*Pinus contorta*) and quaking aspen (*Populus tremuloides*) may dominate after wildfires. In the northern Rockies, the montane zone is often dominated by western red cedar and western hemlock, along with Douglas-fir, western white pine (*P. monticola*), western larch (*Larix occidentalis*), grand fir, and ponderosa pine (Bailey 1995).

Sierra Nevada Mountains (MLRA 22A)

The Sierra Nevada Mountains in California (MLRA 22A in LRR D) are included in the Western Mountains, Valleys and Coast Region (Figure 1). The Sierra range is 50 to 80 mi (80 to 130 km) wide and approximately 400 mi (645 km) long, and rises gently on the west side to a steep eastern escarpment. The highest peaks commonly exceed 12,000 ft (3,660 m). Mount Whitney at 14,494 ft (4,419 m) is the highest in the contiguous United States. Most areas in the mountains receive 40 to 80 in. (1,015 to 2,030 mm) of precipitation each year, with less in the foothills and lower valleys. Average annual temperature ranges from 25 to 63 ºF (−4 to 17 ºC), and summers are dry (USDA Natural Resources Conservation Service 2006a).

The area supports coniferous forest vegetation distributed in altitudinal zones. The most abundant species in the lower montane zone include ponderosa pine, Jeffrey pine (*Pinus jeffreyi*), Douglas-fir, sugar pine (*P. lambertiana*), white fir (*Abies concolor*), California red fir (*A. magnifica*), and incense cedar (*Calocedrus decurrens*). The subalpine zone supports mountain hemlock, California red fir, lodge-pole pine, western white pine, and whitebark pine (Bailey 1995).

Southern Cascade Mountains (MLRA 22B)

This southern end of the Cascade Mountain range consists of volcanic hills and peaks rising generally to 8,200 ft (2,500 m) but as high as 14,162 ft (4,318 m) on Mount Shasta (Figure 1). Average annual precipitation is typically 15 to 80 in. (380 to 2,030 mm) and average annual temperature is 33 to 62 ºF (1 to 17 ºC) (USDA Natural Resources Conservation Service 2006a).

Low-elevation mixed conifer forests are dominated by ponderosa pine in association with incense cedar and California black oak (*Quercus kelloggii*) on the western slopes and Jeffrey pine on the eastern slopes. Higher elevations support white fir, sugar pine, ponderosa pine, incense cedar, Douglas-fir, California black oak, lodge-pole pine, and California red fir (USDA Natural Resources Conservation Service 2006a).

Arizona and New Mexico Mountains (MLRA 39)

This area consists of steep foothills, mountains, and plateaus formed of sedimentary and volcanic rocks (Figure 1). In general, elevation ranges from 4,000 to more than 7,500 ft (1,220 to 2,285 m) with some peaks above 11,000 ft (3,350 m). Average annual precipitation is 15 to 30 in. (380 to 760 mm) with as much as 43 in. (1,090 mm) in the mountains. Average annual temperature is 36 to 55 ºF (2 to 13 ºC) (USDA Natural Resources Conservation Service 2006a).

Lower elevations and south-facing slopes support a mixture of grasses, brush, oak/juniper woodlands, and pinyon/juniper woodlands. Ponderosa pine forests begin at approximately 7,000 ft (2,100 m) elevation and grade into Douglas-fir forests at higher elevations. Where present, the subalpine zone supports Engelmann spruce, corkbark fir (*Abies lasiocarpa* var. *arizonica*), limber pine (*Pinus flexilis*), and bristlecone pine (*P. aristata*) (Bailey 1995).

Black Hills (MLRA 62)

The Black Hills rise out of the surrounding plains of western South Dakota and eastern Wyoming (Figure 1). Elevation ranges generally from 3,600 to 6,600 ft (1,100 to 2,010 m) with a high of 7,242 ft (2,208 m). Average annual precipitation is 16 to 37 in. (405 to 940 mm) and average annual temperature is 36 to 48 ºF (2 to 9 ºC) (USDA Natural Resources Conservation Service 2006a).

Forests in the Black Hills are dominated by ponderosa pine, with white spruce (*Picea glauca*) at higher elevations. There are no significant subalpine or alpine zones. Paper birch (*Betula papyrifera*) and quaking aspen occur on burned or cleared sites (Bailey 1995, USDA Natural Resources Conservation Service 2006a).

Types and Distribution of Wetlands

General

In contrast to the surrounding Arid West and Great Plains Regions, the Western Mountains, Valleys and Coast Region receives adequate to abundant precipitation. Diverse and heterogeneous landscapes produce many settings where wetlands have formed. Nonetheless, wetlands and other shallow aquatic habitats occupy only a few percent of the land surface (Dahl 1990). Regional wetland types range from tidal salt marshes, tidal freshwater wetlands, interdunal wetlands, wet pygmy forests, wet meadows and pastures, and forested wetlands in coastal areas of Washington, Oregon, and northern California to snowmelt-fed wet meadows, fens, bogs, slope wetlands, seeps, forested wetlands, and riparian wetlands in the mountains throughout the region. Intermountain valleys between major mountain ranges contain riparian wetlands, including those in abandoned river channels and oxbow cutoffs, slope wetlands, and wet prairies, many of which have been converted to agricultural production or pasture.

Salt marshes occur in protected bays and in the shallow, low-gradient reaches of coastal rivers but, due to the steep topography of the Pacific Northwest coast, they are not as extensive as those on the Atlantic coast. Salt and brackish marshes in the region often support Lyngbye's sedge (*Carex lyngbyei*), pickleweed (*Salicornia virginica*), and grasses such as saltgrass (*Distichlis spicata*), tufted hairgrass (*Deschampsia caespitosa*), bentgrass (*Agrostis* spp.), and meadow barley (*Hordeum brachyantherum*). Cordgrasses (*Spartina* spp.), not native to the region, have invaded in several areas, notably in Humboldt Bay in northern California and Willapa Bay in Washington. Most estuaries also contain many acres of diked and tide-gated former high salt marsh that was converted to pasture. These areas are now the focus of considerable wetland restoration activity. Tidal freshwater marshes and swamps have always been limited in the region due to relatively steep coastal gradients, but they have also been heavily impacted by human activities and many have been converted to other uses. For example, Sitka spruce swamps are now rare (Christy 1993, Adamus 2005).

Nontidal, freshwater wetlands in coastal areas include the fringes of coastal lagoons and lakes; shrub and forested wetlands in valleys supporting species such as red alder (*Alnus rubra*), willows (e.g., *Salix hookeriana*), water parsley (*Oenanthe sarmentosa*), skunk cabbage (*Lysichiton americanus*), salmonberry (*Rubus spectabilis*), and slough sedge (*Carex obnupta*); *Sphagnum* wetlands with trees such as shore pine (*Pinus contorta* ssp. *contorta*) and western hemlock, shrubs such as Labrador-tea (*Ledum glandulosum*), sweet gale (*Myrica gale*), and bog blueberry (*Vaccinium uliginosum*), and herbaceous plants including California pitcher-plant (*Darlingtonia californica*) and slough sedge; marshes and wet meadows (many diked or partially drained and used for pasture); riparian wetlands typically dominated by red alder; and interdunal wetlands supporting willows (*Salix* spp.), sickle-leaved rush (*Juncus falcatus*), salt rush (*J. lesueurii*), golden-eyed grass (*Sisyrinchium californicum*), and Pacific silverweed (*Argentina egedii*) (Akins and Jefferson 1973; Christy et al. 1998; Christy 2001).

The Willamette/Puget lowlands, located between the Coast Range and the Cascade Range, once supported vast expanses of wet prairie dominated by tufted hairgrass, California oatgrass (*Danthonia californica*), a variety of sedges (e.g., *Carex densa*, *C. unilateralis*), and common camas (*Camassia quamash*). These prairies were maintained by periodic burning by native Americans. The area also included extensive hardwood-forested wetlands dominated by Oregon ash, Oregon white oak (*Quercus garryana*), and bigleaf maple. Today, only remnants of these wetland systems remain. The most common wetland types today include forested or shrub wetlands dominated by Oregon ash, hardhack (*Spiraea douglasii*), Douglas and English hawthorn (*Crataegus douglasii* and *C. monogyna*), and rose (*Rosa* spp.) with numerous herbaceous species; disturbed prairie wetlands with native species such as tufted hairgrass, California oatgrass, sedges, a variety of herbaceous species such as camas, asters, mints, and buttercups (*Ranunculus* spp.), and introduced grasses; and many acres of agriculturally managed wetlands (Chappell and Christy 2004; Christy 2004).

Many wetlands in the urban and urbanizing areas of the Willamette/Puget lowlands reflect severe and recurrent disturbance. Reed canarygrass (*Phalaris arundinacea*) is well adapted to the flashy hydrology and high sediment and nutrient loads running off urban landscapes, and its prodigious mats of rhizomes exclude competitors. Opportunistic native species such as common cattail (*Typha latifolia*) and Douglas spirea are also typical of low-diversity wetlands in urban areas. Non-native weedy invaders include bittersweet nightshade (*Solanum dulcamara*), soft rush (*Juncus effusus*), creeping buttercup (*Ranunculus repens*), purple loosestrife (*Lythrum salicaria*), Himalayan blackberry (*Rubus armeniacus*), Japanese knotweed (*Polygonum cuspidatum*), giant knotweed (*Polygonum sachalinense*), and a common hybrid of the two, *Polygonum* x *bohemicum* (Cooke and Azous 2001, Zika and Jacobson 2003).

High-elevation wetlands in the Western Mountains, Valleys and Coast Region are found in meadows, along lake shores, and along streams in steep-sided valleys that provide limited space for wetlands to form. Therefore, wetlands in the mountains, although numerous in some areas, generally are small and scattered. Areas that were subject to mountain glaciation during the Pleistocene, including the Sierra Nevada, Cascade, and Olympic mountain ranges, isolated ranges in the Great Basin, and scattered portions of the Rocky Mountains, today support numerous wetlands in glacial basins, kettle holes, along meandering streams in U-shaped valleys, around moraine-dammed lakes, and in flat areas formed by filling of moraine lakes with glacial outwash and alluvium. Near treeline throughout the mountain region, nivation depressions (formed by the weight of snow over saturated soils) and solifluction terraces (formed by down-slope movement of wet soils over seasonal ice or bedrock) form numerous small ponds and depressional wetlands (Windell et al. 1986).

At lower elevations, unglaciated V-shaped canyons incised by rushing streams and rivers generally have little floodplain development and few wetlands except, perhaps, for a narrow riparian fringe. Wetland abundance and diversity are much greater in the level to rolling alluvial deposits of intermountain basins and valleys, such as the Stanley Valley in Idaho, Jackson Hole in Wyoming, and Middle Park in Colorado. These same areas are often used intensively for agriculture, grazing, human settlement, and wildlife refuges (Windell et al. 1986).

Mountain wetlands include fens, bogs, marshes, wet meadows, and various shrub and forested wetlands (Windell et al. 1986). Fens and bogs occur on organic or organic-rich mineral soils in areas where the water table is near the surface for much of the year. Fens are common in the Rocky Mountains, Sierra Nevada Mountains, and other western mountain ranges. They receive inputs of nutrient-rich groundwater and support dense herbaceous communities dominated by sedges (e.g., *Carex aquatilis* and *C. utriculata*), rushes (*Juncus* spp.), spikerushes (e.g., *Eleocharis acicularis*), and grasses (e.g., *Calamagrostis canadensis*, *Deschampsia caespitosa, Vahlodea atropurpurea*). Some fens support a woody overstory of willows (e.g., *Salix planifolia*, *S. wolfii*) and dwarf birch (*Betula glandulosa*) (Windell et al. 1986). Bogs, on the other hand, are not common in the region but may be found in Oregon, Washington, and the northern Rocky Mountains (NatureServe 2006). They are acidic and nutrient-poor, receiving much of their water from precipitation. Bogs usually support a moss layer dominated by *Sphagnum* and ericaceous shrubs (e.g., *Ledum* spp.).

Marshes and wet meadows support herbaceous plant species and develop on mineral soils, some with high organic content, that are seasonally ponded or saturated. Marshes are wetter systems often bordering open water and may grade into wet meadows upslope. Wet meadows also lie in or below snowbeds that supply water for a few weeks each year as the snow melts. In the Rocky Mountains, freshwater marshes and wet meadows are often dominated by sedges, rushes, grasses (e.g., *Calamagrostis canadensis*, *Deschampsia caespitosa*), and herbaceous dicots (e.g., *Cardamine cordifolia*, *Erigeron peregrinus*). In saline systems in some intermountain basins, wet meadows may be dominated by salt-tolerant grasses (e.g., *Distichlis spicata*, *Sporobolus airoides*).

Narrow ribbons of wetland dominated by flowering plants exist along many small streams in the alpine, subalpine, and montane zones of western mountain ranges. Common species include larkspur (*Delphinium* spp.), monkey-flower (*Mimulus* spp.), monkshood (*Aconitum columbianum*), and groundsel (*Senecio* spp.) (Windell et al. 1986).

Shrub-dominated wetlands on mineral soils occur in floodplains and riparian zones in mountains throughout the region, and dominant species vary with location, elevation, and other factors. Common wetland shrubs in the Rocky Mountains include diamond-leaf willow (*Salix planifolia*), Geyer willow (*S. geyerana*), mountain willow (*S. monticola*), and Drummond willow (*S. drummondiana*). Forested wetlands occur in floodplains, springs, seeps, adjacent to running waters, and in other areas with high water tables. Coniferous trees such as Engelmann spruce, subalpine fir, and lodge-pole pine are sometimes found in wetlands in the Rocky Mountains. At lower elevations in intermountain basins, such as areas transitional to the Arid West or Great Plains Regions, common riparian-wetland species include narrow-leaf cottonwood (*Populus angustifolia*), balsam poplar (*P. balsamifera*), Fremont cottonwood (*P. fremontii*), and sandbar willow (*S. exigua*) (Windell et al. 1986).

Irrigated Wetlands

Irrigation has been practiced in some portions of the Western Mountains, Valleys and Coast Region for more than 125 years and has changed the natural hydrologic regime over large areas. When practiced over many years, the application of irrigation water can alter soil characteristics (e.g., color, redox features, and salt content) and vegetation of affected areas. Long-term irrigation has created new wetlands and altered existing wetlands throughout the region.

Irrigation augments the natural hydrology of the affected areas in both intended and unintended ways, through leakage of water from delivery channels and ditches, application of water to irrigated pastures and fields, and overflow of unused or excess irrigation water into other areas down gradient. The added water, over time, may create new wetlands or augment and enlarge previously existing wetlands. For example, seep wetlands may develop in former uplands due to leakage from irrigation canals and ditches; prolonged flooding and soil saturation may induce soil redoximorphic features and hydrophytic vegetation in irrigated pastures; and the accumulation of excess irrigation water in basins and swales may augment previously existing wetlands, raising their water tables and expanding their margins farther up slope. Indicators given in this Regional Supplement can be used to identify all wetlands, whether natural or created artificially by human activity. Characterizing the naturally occurring hydrology is often key to distinguishing natural from irrigation-induced wetlands, and the timing of field observations can be critical. Observations made during the early part of the growing season, when natural hydrology is often at its peak and irrigation has not yet begun, may help to differentiate natural and induced wetland features. The appropriate Corps of Engineers District Regulatory Office should be consulted when it is necessary to distinguish between naturally occurring and irrigation-induced wetlands for Clean Water Act regulatory purposes.

2 Hydrophytic Vegetation Indicators

Introduction

In wetlands, the presence of water for long periods during the growing season exerts a controlling influence on the vegetation and determines which plant species can establish and maintain themselves. Therefore, certain characteristics of the vegetation are strong evidence for the presence of wetlands on a site. The Corps Manual uses a plant-community approach to evaluate vegetation. Hydrophytic vegetation decisions are based on the assemblage of plant species growing on a site, rather than the presence or absence of particular indicator species. In general, hydrophytic vegetation is present when the plant community is dominated by species that can tolerate prolonged inundation or soil saturation during the growing season.

Many factors in addition to site wetness affect the composition of the plant community in an area, including regional climate, local weather patterns, topography, soils, and plant distribution patterns at various spatial and temporal (historic to current) scales. The vegetation of the Western Mountains, Valleys and Coast Region is characterized by high overall diversity of species, plant communities, and associations due in part to the greater variety of available environments and plant adaptive strategies than in other regions of the contiguous United States. Species diversity varies greatly from east to west, north to south, and along elevation gradients. The flora of the region has been shaped by the uplift of mountains and other major geologic forces, post-glacial changes in plant distribution patterns, and speciation in response to the availability of diverse habitats and climatic conditions. Western mountain ranges have acted both as corridors and barriers to plant migration (Weber 1976). Different subregions of the Western Mountains, Valleys and Coast Region tend to have distinct vegetation but still have many shared species. Uniform climatic influences along the Pacific Ocean have created similar floristic compositions from north to south along the coastal mountain ranges. The eastern slopes and higher elevations of the Cascade and Sierra Nevada Mountain ranges have a distinct flora from that of the coastal ranges. The Rocky Mountains from Canada to southern New Mexico have vegetation influenced by both elevation and latitudinal gradients, adding to the complexity of the region (Allen, Peet, and Baker 1991). Valleys interspersed within the mountains often have different climatic conditions and a greater variety of soil types that add to plant diversity. Finally, high-elevation areas within the major mountain ranges share many glacial relict species but also have many endemics derived from their local floras. Thus, western landscapes contain a wide variety of habitats requiring an array of adaptations for plants to survive in areas ranging from alpine tundra, mountain slopes and valleys, high plateaus, and riparian corridors to temperate rain forests, tidal systems, and coastal strand.

Coniferous forest is the dominant forest type in the region. Deciduous trees are generally restricted to young forest stands, riparian corridors, and many disturbed sites. Exceptions include large stands of aspen (*Populus tremuloides*) and oak woodlands (e.g., *Quercus gambellii*) located in montane settings. Dry summers, cold winters, and short growing seasons generally restrict the occurrence of deciduous forest in the region.

Temperate rain forests of the northern Coast Ranges are dominated by coniferous species and have complex vegetation structure and a wide range of tree sizes and ages. These forests contain species that are adapted to both wetland and upland sites. Heavy and frequent rainfall may be advantageous to many wetland species in the rain forest but many sites may lack hydric soils or wetland hydrology indicators.

In foothills and intermountain basins in the interior, climatic fluctuations can produce seasonal and decadal-scale shifts in wetland species composition. Changes in species composition of woody shrubs and trees in wetlands are generally not dramatic. Decade-long drought conditions may stress woody plants but they typically survive and persist at drought-influenced wetland sites. Herbaceous wetland communities, however, respond much more quickly and dramatically. Vernal pools and other depressional wetlands, wet prairies, seeps, and springs in this region are particularly prone to shifts in species composition as a result of seasonal and longer term climatic fluctuations.

Saline wetlands and small lakes with halophytic vegetation are found throughout the region, particularly in southern intermountain valleys. Halophytes have morphological and physiological adaptations that allow them to persist in highly saline soil and water conditions. In addition, phreatophytes with long taproots adapted to reach deep subsurface water tables are associated with rivers and streams throughout the region. Although often found in wetlands, halophytes and phreatophytes located in areas with ephemeral hydrology can sometimes be misleading indicators of wetland conditions. They may dominate plant communities in areas that are highly saline but lack wetland hydrology or hydric soils, or they may occur in areas where groundwater is below the depth required to meet wetland criteria.

In summary, plant community composition reflects the adaptations of the plant species present, superimposed on a complex spatial and historical pattern of hydrologic, edaphic, and other environmental conditions. Disturbances, such as floods, wildfires, grazing, and recent site modifications, are also important. They can set back or alter the course of plant-community succession and may even change the hydrophytic status of the vegetation. See Chapter 5 for discussions of problematic wetland vegetation situations in the region.

Hydrophytic vegetation decisions are based primarily on the wetland indicator status (Reed 1988, 1993 supplement in Region 9) of species that make up the plant community. Species in the facultative categories (FACW, FAC, and FACU) are recognized as occurring in both wetlands and non-wetlands to varying degrees. Although most wetlands are dominated mainly by species rated OBL, FACW, and FAC, some wetland communities may be dominated primarily by FACU species, such as western hemlock, and cannot be identified by dominant species alone. In those cases, other indicators of hydrophytic vegetation must also be considered. This situation is not necessarily due to inaccurate wetland indicator ratings; rather, it is due to the broad tolerances of certain plant species that allow them to be widely distributed across the moisture gradient. Therefore, for some species, it is difficult to assign a single indicator status rating that encompasses all of the various landscape and ecological settings it can occupy.

Hydrophytic vegetation indicators and procedures presented in this chapter are designed to identify the majority of wetland plant communities in the region. However, some wetland communities may lack any of these indicators. These situations are considered in Chapter 5 (Difficult Wetland Situations in the Western Mountains, Valleys and Coast Region).

Guidance on Vegetation Sampling and Analysis

General guidance on sampling of vegetation for wetland-delineation purposes is given in the Corps Manual for both the Routine and Comprehensive methods. Those procedures are intended to be flexible and often need to be modified for application in a given region or on a particular site. Vegetation sampling done as part of a wetland delineation is designed to characterize the site in question rapidly without the need for detailed scientific study or statistical methods. A balance must be struck between the need to accomplish the work quickly and the need to characterize the site's heterogeneity accurately and at an appropriate scale. The following guidance on vegetation sampling is intended to supplement the Corps Manual for applications in the Western Mountains, Valleys and Coast Region.

The first step is to stratify the site so that the major landscape or vegetation units can be evaluated separately. This may be done in advance using an aerial photograph or topographic map, and/or by walking over the site. In general, routine wetland determinations are based on visual estimates of percent cover of plant species that can be made either (1) within the vegetation unit as a whole or (2) within one or more sampling plots established in representative locations within each unit. Percent cover estimates are more accurate and repeatable if taken within a defined plot. This also facilitates field verification of another delineator's work. The sizes and shapes of plots, if used, may be modified as appropriate to adapt to site conditions and should be recorded on the field data form if they deviate from those recommended in the Corps Manual. Near the wetland boundary, it may be necessary to adjust plot size or shape to avoid overlapping the boundary and extending into an adjacent community having different vegetation, soils, or hydrologic conditions. For wetland delineation purposes, an area is considered to be vegetated if it has 5 percent or more total plant cover at the peak of the growing season. See "Sparse and Patchy Vegetation" in Chapter 5 for a discussion of areas that contain both vegetated and unvegetated wet areas.

If it is not possible to locate one or a few plots in a way that adequately represents the vegetation unit being sampled, then percent cover estimates can be obtained by walking the unit and visually estimating the coverage of each species over a broader area. If additional quantification of cover estimates is needed, then the optional procedure for point-intercept sampling along transects (see Appendix B) may be used to characterize the vegetation unit, as long as soil and hydrologic conditions are uniform across the area.

Vegetation sampling guidance presented here and in the Corps Manual should be appropriate for most situations. However, many variations in vegetation structure, diversity, and spatial arrangement exist on the landscape and not all can be addressed adequately in this supplement. A list of references is given in Table 2-1 for more complex sampling situations. If alternative sampling techniques are used, they should be described in field notes or in the delineation report. The basic data must include abundance values for each species present. Typical abundance measures include basal area (for trees), percent areal cover, stem density, or frequency based on point-intercept sampling. Percent cover is the preferred measure for all species. In any case, the data must be in a format that can be used in the dominance test or prevalence index for hydrophytic vegetation (see Hydrophytic Vegetation Indicators).

Table 2-1
Selected references to additional vegetation sampling approaches that could be used in wetland delineation.

Reference	Comment
Elzinga, C. L., Salzer, D. W., and Willoughby, J. W. (1998). *Measuring and Monitoring Plant Populations*. Bureau of Land Management Technical Reference 1730-1. U.S. Dept. of the Interior, Washington, DC.	Clearly presented and easy-to-read information on determining sample size and adequacy.
Kent, M., and Coker, P. (1992). *Vegetation Description and Analysis: A Practical Approach.* Wiley, New York.	Simple and clear methods for setting up a study, and collecting and analyzing the data. Initial chapters are helpful for data collection and sampling approaches in wetland delineation.
Mueller-Dombois, D., and Ellenberg, H. (1974). *Aims and Methods of Vegetation Ecology*. Wiley, New York.	A standard text in vegetation ecology, sampling, and analysis. This reference provides many sampling and analytical methods that are helpful in complex delineations.

Definitions of Strata

Vegetation strata are sampled separately when evaluating indicators of hydrophytic vegetation. The structure of vegetation varies greatly in wetland communities across the region. Throughout much of the Western Mountains, Valleys and Coast Region, short-statured woody plants (i.e., less than 3.2 ft (1 m) high or “sub-shrubs”) are a common growth form. The Corps Manual combines short woody plants and herbaceous plants into a single “herb” stratum for sampling purposes. However, in the Western Mountains, Valleys and Coast Region, more information about the plant community is gained when short shrubs and herbaceous plants are sampled separately. Therefore, the following vegetation strata are recommended for use across the region. This system places short woody shrubs in the sapling/shrub stratum and limits the herb stratum to only herbaceous plant species. Unless otherwise noted, a stratum for sampling purposes is defined as having 5 percent or more total plant cover. If either the tree or woody vine strata have less than 5 percent cover during the peak of the growing season, then any trees or vines present may be combined with the sapling/shrub stratum.

1. *Tree stratum* – Consists of woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH).

2. *Sapling/shrub stratum* – Consists of woody plants less than 3 in. DBH, regardless of height.

3. *Herb stratum* – Consists of all herbaceous (non-woody) plants, including herbaceous vines, regardless of size.

4. *Woody vines* – Consists of all woody vines, regardless of height.

Sampling Wetland Non-Vascular Plants

Background. Non-vascular plants, defined here as bryophytes (mosses, liverworts, hornworts), lichens, and fungi, form extensive ground cover in forest, bog, and fen ecosystems in the Pacific Northwest. The non-vascular plant flora of this area is diverse and the identification of species can be challenging even to experts due to ephemeral or missing fruiting structures and minute differences in morphological characteristics. A list of common and relatively easy-to-identify bryophyte species that are highly associated with wetlands in the Pacific Northwest is currently under development using an approach pioneered by Laursen et al. (2005) and Lichvar et al. (2006, in review) in Alaska. The Corps Manual does not specifically include non-vascular plants in hydrophytic vegetation decisions. However, in this regional supplement, the presence and abundance of certain wetland non-vascular plant species may be used as an indicator of hydrophytic vegetation in situations where indicators of hydric soil and wetland hydrology are also present.

The current study focuses on western hemlock (*Tsuga heterophylla*) forests in Oregon and Washington to identify non-vascular plant species that are strongly associated with wetlands and, when sufficiently abundant, constitute a nearly "test positive" indicator of hydrophytic vegetation. Preliminary surveys of all non-vascular plant species observed along a wetland-to-upland transect at one study area in Oregon revealed that bryophytes had the highest fidelity for wetland conditions within this western hemlock forest. Wetland-specialist bryophytes were defined as those having 67 percent or higher frequency of occurrence in wetlands. When one or more of these species comprised more than 50 percent of the total bryophyte cover, the bryophyte indicator had a greater than 90 percent probability of association with wetlands. A preliminary list of bryophyte species to be used with the wetland non-vascular plant indicator is presented in Table 2-2.

Table 2-2 **Preliminary List of Bryophyte Species That Are Highly Associated with Wetlands near Cullaby Lake in Warrenton, OR**
Eurhynchium praelongum *Sphagnum angustifolium* *Sphagnum palustre*

Plot Size. To determine whether hydrophytic vegetation is present using the non-vascular plant layer, areal cover estimates are recorded for all bryophytes within a plot. Due to the sorting of different species on the tops of hummocks versus the swales, sampling of bryophytes is restricted to the swales located between and at the bases of hummocks and utilizes a 10- by 10-in. (25- by 25-cm) quadrat. To ensure that the sampling plots adequately capture species diversity, three quadrats are suggested, if space is available. Data from these three plots can be combined and averaged to determine if the indicator is met.

Snow and Ice

Excessive snow and ice is defined as an accumulation that covers the ground and makes it impractical to identify plant species and estimate plant cover. When an on-site evaluation of hydrophytic vegetation is impractical due to excessive snow and ice, the following option is recommended:

- An off-site wetland determination at a preliminary level can be made by utilizing existing off-site data sources such as National Wetlands Inventory (NWI) maps, soil surveys, and aerial photographs. These sources may be supplemented with limited on-site data, including those plant species that can be identified. Later, when site and weather conditions are favorable, an on-site investigation must be made to verify the preliminary determination and complete the wetland delineation.

Hydrophytic Vegetation Indicators

The Corps Manual defines hydrophytic vegetation as the community of macrophytes that occurs in areas where inundation or soil saturation is either permanent or of sufficient frequency and duration to exert a controlling influence on the plant species present. Hydrophytic vegetation is identified by applying the indicators described in this section.

The following indicators should be applied in the sequence presented. Hydrophytic vegetation is present if any of the indicators is satisfied. However, some indicators have the additional requirement that indicators of hydric soil and wetland hydrology must also be present. These indicators are applicable throughout the entire Western Mountains, Valleys and Coast Region.

For the purposes of this supplement, only the five basic levels of wetland indicator status (i.e., OBL, FACW, FAC, FACU, and UPL) (Reed 1988) are used in hydrophytic vegetation indicators. Plus (+) and minus (–) modifiers are not used (e.g., FAC–, FAC, and FAC+ plants are all considered to be FAC). Species not listed on the wetland plant list are assumed to be UPL species (Reed 1988). For Clean Water Act purposes, wetland delineators should use the latest plant lists approved by Headquarters, U.S. Army Corps of Engineers (Figure 2-1) (http://www.usace.army.mil/inet/functions/cw/cecwo/reg/reg_supp.htm).

The dominance test (Indicator 1) is the basic hydrophytic vegetation indicator and should be applied in every wetland determination. Most wetlands in the Western Mountains, Valleys and Coast Region have plant communities that will pass the dominance test, and this is the only indicator that needs to be used in most situations. However, some wetland plant communities may fail a test based only on dominant species. Therefore, in those cases where indicators of hydric soil and wetland hydrology are present, the vegetation should be re-evaluated with the prevalence index (Indicator 2), which takes into consideration all plant species in the community, not just a few dominants. In addition, plant morphological adaptations (Indicator 3) and wetland bryophytes (Indicator 4) can be used to distinguish certain wetland plant communities in the region, when indicators of hydric soil and wetland hydrology are present. Finally, certain problematic wetland situations may lack any of these indicators and are described in Chapter 5.

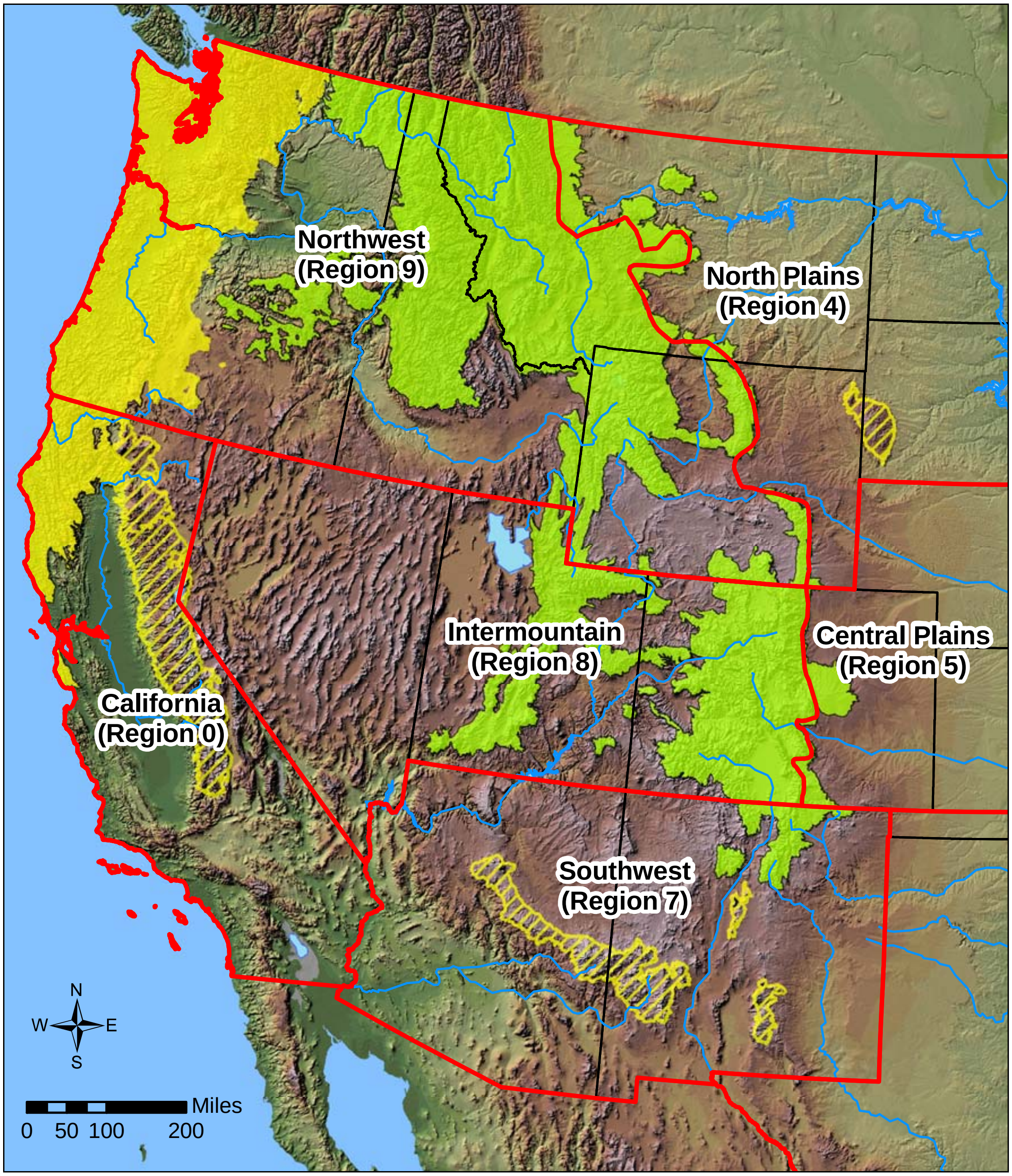

Figure 2-1. Plant list regional boundaries (red lines) currently used by the U.S. Fish and Wildlife Service, National Wetlands Inventory, in the Western Mountains, Valleys and Coast Region.

Procedure

The procedure for using hydrophytic vegetation indicators is as follows:

1. Apply Indicator 1 (Dominance Test) first.

   a. If the plant community passes the dominance test, then the vegetation is hydrophytic and no further vegetation analysis is required.

b. If the plant community fails the dominance test, and indicators of hydric soil and/or wetland hydrology are absent, then hydrophytic vegetation is absent unless the site meets requirements for a problematic wetland situation (see Chapter 5).

c. If the plant community fails the dominance test, but indicators of hydric soil and wetland hydrology are both present, proceed to step 2.

2. Apply Indicator 2 (Prevalence Index). This and the following step assume that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present.

   a. If the plant community satisfies the prevalence index, then the vegetation is hydrophytic. No further vegetation analysis is required.

   b. If the plant community fails the prevalence index, proceed to step 3.

3. Apply Indicators 3 (Morphological Adaptations) and 4 (Wetland Non-Vascular Plants).

   a. If either indicator is satisfied, then the vegetation is hydrophytic.

   b. If none of the indicators is satisfied, then hydrophytic vegetation is absent unless indicators of hydric soil and wetland hydrology are present and the site meets the requirements for a problematic wetland situation (Chapter 5).

Indicator 1: Dominance test

Description: More than 50 percent of the dominant plant species across all strata are rated OBL, FACW, or FAC.

User Notes: Use the “50/20 rule” described below to select dominant species from each stratum of the community. Combine dominant species across strata and apply the dominance test to the combined list. Once a species is selected as a dominant, its cover value is not used in the dominance test; each dominant species is treated equally. Thus, a plant community with seven dominant species across all strata would need at least four dominant species that are OBL, FACW, or FAC to be considered hydrophytic by this indicator. Species that are dominant in two or more strata should be counted two or more times in the dominance test.

Procedure for Selecting Dominant Species by the 50/20 Rule: Dominant plant species are the most abundant species in the community; they contribute more to the character of the community than do the other non-dominant species present. The 50/20 rule is a repeatable and objective procedure for selecting dominant plant species and is recommended when data are available for all species in the community.

Dominant species are chosen independently from each stratum of the community. In general, dominants are the most abundant species that individually or collectively account for more than 50 percent of the total coverage of vegetation in the stratum, plus any other species that, by itself, accounts for at least 20 percent of the total. For the purposes of this regional supplement, absolute percent cover is the recommended abundance measure for plants in all vegetation strata. See Table 2-3 for an example application of the 50/20 rule in evaluating a plant community. Steps in selecting dominant species by the 50/20 rule are as follows:

1. Estimate the absolute percent cover of each species in the first stratum. Since the same data may be used later to calculate the prevalence index, the data should be recorded as absolute cover and not converted to relative cover.

2. Rank all species in the stratum from most to least abundant.

3. Calculate the total coverage of all species in the stratum (i.e., sum their individual percent cover values). Absolute cover estimates do not necessarily sum to 100 percent.

4. Select plant species from the ranked list, in decreasing order of coverage, until the cumulative coverage of selected species *exceeds* 50 percent of the total coverage for the stratum. If two or more species are equal in coverage (i.e., they are tied in rank), they should all be selected. The selected plant species are all considered to be dominants. All dominants must be identified to species.

5. In addition, select any other species that, by itself, is at least 20 percent of the total percent cover in the stratum. Any such species is also considered to be a dominant and must be accurately identified.

6. Repeat steps 1-5 for any other stratum present. Combine the lists of dominant species across all strata. Note that a species may be dominant in more than one stratum (e.g., a woody species may be dominant in both the tree and sapling/shrub strata).

Table 2-3
Example of the selection of dominant species by the 50/20 rule.

Stratum	Species Name	Wetland Indicator Status	Percent Cover	Dominant?
Herb	*Deschampsia caespitosa*	FACW	30	Yes
	Carex unilateralis	FACW	15	Yes
	Parentucellia viscosa	FAC	15	Yes
	Danthonia californica	FACU	10	No
	Poa trivialis	FACW	10	No
	Agrostis capillaris	FAC	5	No
	Juncus tenuis	FACW	1	No
		Total cover	86	
	50/20 Thresholds: 50% of total cover = 43% 20% of total cover = 17.2%			
Sapling/shrub	*Crataegus monogyna*	FACU	25	Yes
	Crataegus douglasii	FAC	15	Yes
	Fraxinus latifolia	FACW	5	No
		Total cover	45	
	50/20 Thresholds: 50% of total cover = 22.5% 20% of total cover = 9.0%			
Tree	*Fraxinus latifolia*	FACW	25	Yes
Hydrophytic Vegetation Determination	Total number of dominant species across all strata = 6. Percent of dominant species that are OBL, FACW, or FAC = 83%. Therefore, this community is hydrophytic by Indicator 1 (Dominance Test).			

Indicator 2: Prevalence index

Description: The prevalence index is 3.0 or less.

User Notes: At least 80 percent of the total vegetation cover on the plot (summed across all strata) must be of species that have been correctly identified and have an assigned wetland indicator status (including UPL for species not recorded on the list of wetland plants (Reed 1988)).

Procedure for Calculating a Plot-Based Prevalence Index: The prevalence index is a weighted-average wetland indicator status of all plant species in the sampling plot or other sampling unit, where each indicator status category is given a numeric code (OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5) and weighting is by abundance (percent cover). It is a more comprehensive analysis of the hydrophytic status of the community than one based on just a few dominant species. It is particularly useful (1) in communities with only one or two dominants, (2) in highly diverse communities where many species may be present at roughly equal coverage, and (3) when strata differ greatly in total plant cover (e.g., total herb cover is 80 percent but sapling/shrub cover is only 10 percent). The prevalence index is used in this supplement to determine whether hydrophytic vegetation is present on sites where indicators of hydric soil and wetland hydrology are present but the vegetation initially fails the dominance test.

The following procedure is used to calculate a plot-based prevalence index. The method was described by Wentworth, Johnson and Kologiski (1988) and modified by Wakeley and Lichvar (1997). It uses the same field data (i.e., percent cover estimates for each plant species) that were used to select dominant species by the 50/20 rule, with the added constraint that at least 80 percent of the total vegetation cover on the plot must be of species that have been correctly identified and have an assigned indicator status (including UPL for those species not on the wetland plant list). For any species that occurs in more than one stratum, cover estimates are summed across strata. Steps for determining the prevalence index are as follows:

1. Identify and estimate the absolute percent cover of each species in each stratum of the community. Sum the cover estimates for any species that is present in more than one stratum.

2. Organize all species (across all strata) into groups according to their wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL) and sum their cover values within groups. Do not include species that were not identified. Species that were identified correctly but are not recorded on the wetland plant list are assumed to be upland (UPL) species. For species listed NI (reviewed but given no regional indicator), apply the national indicator status to the species. If no regional indicator is assigned and more than one national indicator status is assigned, do not use the species to calculate the prevalence index. If the species is listed but no regional or national indicator is assigned, do not use the species.

3. Calculate the prevalence index using the following formula:

$$PI = \frac{A_{OBL} + 2A_{FACW} + 3A_{FAC} + 4A_{FACU} + 5A_{UPL}}{A_{OBL} + A_{FACW} + A_{FAC} + A_{FACU} + A_{UPL}}$$

where:

PI	=	Prevalence index
A_{OBL}	=	Summed percent cover values of obligate (OBL) plant species;
A_{FACW}	=	Summed percent cover values of facultative wetland (FACW) plant species;
A_{FAC}	=	Summed percent cover values of facultative (FAC) plant species;
A_{FACU}	=	Summed percent cover values of facultative upland (FACU) plant species;
A_{UPL}	=	Summed percent cover values of upland (UPL) plant species.

The prevalence index should range between 1 and 5. See Table 2-4 for an example calculation of the prevalence index using the same data set as in Table 2-3. The following web link provides free public-domain software for simultaneous calculation of the 50/20 rule, dominance test, and prevalence index: http://www.crrel.usace.army.mil/rsgisc/wetshed/wetdatashed.htm.

Table 2-4
Example of the Prevalence Index using the same data as in Table 2-3.

Indicator Status Group	Species name	Percent Cover by Species	Total Cover by Group	Multiply by:[1]	Product
OBL species	None	0	0	1	0
FACW species	*Deschampsia caespitosa* *Carex unilateralis* *Poa trivialis* *Juncus tenuis* *Fraxinus latifolia*[2]	30 15 10 1 30	86	2	172
FAC species	*Parentucellia viscosa* *Agrostis capillaris* *Crataegus douglasii*	15 5 15	35	3	105
FACU species	*Danthonia californica* *Crataegus monogyna*	10 25	35	4	140
UPL species	None	0	0	5	0
Sum			156 (A)		417 (B)
Hydrophytic Vegetation Determination		Prevalence Index = B/A = 417/156 = 2.67 Therefore, this community is hydrophytic by Indicator 2 (Prevalence Index).			

[1] Where OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5.
[2] *Fraxinus latifolia* was recorded in two strata (see Table 2-2), so the cover estimates for this species were summed across strata.

Indicator 3: Morphological adaptations

Description: The plant community passes either the dominance test (Indicator 1) or the prevalence index (Indicator 2) after reconsideration of the indicator status of certain plant species that exhibit morphological adaptations for life in wetlands.

User Notes: Some hydrophytes in the Western Mountains, Valleys and Coast Region develop easily recognized physical characteristics, or morphological adaptations, when they occur in wetland areas. Some of these adaptations may help them to survive prolonged inundation or saturation in the root zone; others may simply be a consequence of living under such wet conditions. Common morphological adaptations in the region include, but are not limited to, adventitious roots, multi-stemmed trunks, tussocks, and buttressing in tree species. These adaptations on FAC, FACW, or OBL species are additional evidence for the presence of a hydrophytic plant community. Morphological adaptations may also develop on FACU species when they occur in wetlands, indicating that those individuals are functioning as hydrophytes in that setting.

To apply this indicator, these morphological features must be observed on more than 50 percent of the individuals of a FACU species living in an area where indicators of hydric soil and wetland hydrology are present. Follow this procedure:

1. Confirm that the morphological feature is present mainly in the potential wetland area and is not also common on the same species in the surrounding non-wetlands.

2. For each FACU species that exhibits morphological adaptations, estimate the percentage of individuals that have the features. Record this percentage on the data form.

3. If more than 50 percent of the individuals of a FACU species have morphological adaptations for life in wetlands, that species is considered to be a hydrophyte and its indicator status on that plot should be re-assigned as FAC. All other species retain their published indicator statuses. Record any supporting information on the data sheet, including a description of the morphological adaptation(s) present and any other observations of the growth habit of the species in adjacent wetland and upland locations (photo documentation is recommended).

4. Recalculate the dominance test (Indicator 1) and/or the prevalence index (Indicator 2) using a FAC indicator status for this species. The vegetation is hydrophytic if either test is satisfied.

Indicator 4: Wetland Non-Vascular Plants

Description: More than 50 percent of the total coverage of bryophytes consists of species known to be highly associated with wetlands (Table 2-2).

User Notes: This indicator is based on the presence and abundance of a select group of wetland specialist bryophytes that are specific to forested wetlands (e.g., western hemlock swamps) in coastal Oregon and Washington. The indicator may also be applicable in other parts of the region but has not been tested there. To satisfy this indicator, the summed cover of wetland specialist bryophytes must be more than 50 percent of the total bryophyte cover in the plot. Follow this procedure:

1. Estimate the total cover of bryophytes (mosses, liverworts, and hornworts) within one or more 10- by 10-in. (25- by 25-cm) square plots placed at the base of any hummocks, if present. Lichens and fungi should not be included.

2. Estimate the percent cover for each of the wetland specialist bryophytes (Table 2-2) present and sum their cover values within plots.

3. Divide the summed cover value of wetland specialist bryophytes by the total bryophyte cover in the plot and multiply by 100 to convert to a percentage. Average these percentages across plots, if needed.

4. If more than 50 percent of the bryophyte cover consists of wetland specialists, then the vegetation is hydrophytic.

3 Hydric Soil Indicators

Introduction

The National Technical Committee for Hydric Soils (NTCHS) defines a hydric soil as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1994). Nearly all hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation for more than a few days. Saturation or inundation, when combined with microbial activity in the soil, causes the depletion of oxygen. This anaerobiosis promotes certain biogeochemical processes, such as the accumulation of organic matter and the reduction, translocation, or accumulation of iron and other reducible elements. These processes result in distinctive characteristics that persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils in the field (USDA Natural Resources Conservation Service 2006b).

This chapter presents indicators that are designed to help identify and delineate hydric soils in the Western Mountains, Valleys and Coast Region. Indicators are not intended to replace or relieve the requirements contained in the definition of a hydric soil. Therefore, a soil that meets the definition of a hydric soil is hydric whether or not it exhibits indicators. This list of indicators is dynamic; changes and additions are anticipated with new research and field testing. These indicators are a subset of the NTCHS *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) that are commonly found in the region. Any change to the NTCHS *Field Indicators of Hydric Soils in the United States* represents a change to this subset of indicators for the Western Mountains, Valleys and Coast Region (http://soils.usda.gov/use/hydric/). To use the indicators properly, a basic knowledge of soil/landscape relationships is necessary.

Most of the hydric soil indicators presented in this supplement are applicable throughout the Western Mountains, Valleys and Coast Region; however, some are specific to certain subregions. As used in this supplement, subregions are equivalent to the Land Resource Regions (LRR) or Major Land Resource Areas (MLRA) recognized by the USDA Natural Resources Conservation Service (2006a) (see Chapter 1, Figure 1). It is important to understand that boundaries between subregions are actually broad transition zones. Although an indicator may be noted as most relevant in a specific subregion, it may also be applicable in the transition to an adjacent subregion.

The indicators are used to help identify the hydric soil component of wetlands; however, some hydric soils do not have any of the currently listed indicators. The absence of any listed indicator does not preclude the soil from being hydric. Guidance for identifying hydric soils that lack indicators can be found in this chapter (see the sections on documenting the site and its soils) and in Chapter 5 (Difficult Wetland Situations in the Western Mountains, Valleys and Coast Region).

Concepts

Hydric soil indicators are formed predominantly by the accumulation or loss of iron, manganese, sulfur, or carbon compounds. The presence of hydrogen sulfide gas (producing a rotten egg odor) is a strong indicator of a hydric soil, but this indicator is found only in the wettest sites in soils that contain sulfur-bearing compounds. While indicators related to iron or manganese depletion or concentration are the most common, they cannot form in soils whose parent materials contain low amounts of Fe or Mn. Soils formed in such materials may have low-chroma colors that are not related to saturation and reduction. For such soils, features formed through accumulation of organic carbon should be used.

Organic Matter Accumulation

Since the efficiency of soil microbes is considerably lower in a saturated and anaerobic environment, less organic matter and organic carbon is consumed. Therefore, in saturated or inundated soils, organic matter and carbon begin to accumulate. The result in wetlands is often the development of thick organic surfaces, such as peat or muck, or dark organic-rich surface mineral layers.

Texturing Soil Material High in Organic Carbon. Material high in organic carbon could fall into three categories: organic, mucky mineral, or mineral. In lieu of laboratory data, the following estimation method can be used for soil material that is wet or nearly saturated with water. This method may be inconclusive with loamy or clayey textured mineral soils. Gently rub the wet soil material between forefinger and thumb. If upon the first or second rub the material feels gritty, it is mineral soil material. If after the second rub the material feels greasy, it is either mucky mineral or organic soil material. Gently rub the material two or three more times. If after these additional rubs it feels gritty, it is mucky mineral soil material; if it still feels greasy, it is organic soil material. If the material is organic soil material a further division should be made, as follows.

Organic soil materials are classified as sapric, hemic, or fibric. Differentiating criteria are based on the percentage of visible fibers observable with a hand lens in an undisturbed state and after rubbing between thumb and fingers 10 times (Table 3-1). Sapric, hemic, and fibric correspond to the textures muck, mucky peat, and peat. If there is a conflict between unrubbed and rubbed fiber content, rubbed content is used. *Live roots are not considered*.

Table 3-1
Proportion of Fibers Visible with a Hand Lens

Soil Texture	Unrubbed	Rubbed	Horizon Descriptor
Muck	<33%	<17%	Sapric
Mucky peat	33-67%	17-40%	Hemic
Peat	>67%	>40%	Fibric

Adapted from USDA Natural Resources Conservation Service (1999)

Another field method for determining the degree of decomposition for organic materials is a system modified from a method originally developed by L. von Post and described in detail in ASTM standard D 5715-00. This method is based on a visual examination of the color of the water that is expelled and the soil material remaining in the hand after the sample is squeezed (Table 3-2).

Table 3-2
Determination of Degree of Decomposition of Organic Materials

Degree of Humification	Nature of Material Extruded on Squeezing	Nature of Plant Structure in Residue	Horizon Descriptor
H1	Clear, colorless water; no organic solids squeezed out	Unaltered, fibrous, undecomposed	Fibric
H2	Yellowish water; no organic solids squeezed out	Almost unaltered, fibrous	
H3	Brown, turbid water; no organic solids squeezed out	Easily identifiable	
H4	Dark brown, turbid water; no organic solids squeezed out	Visibly altered but identifiable	Hemic
H5	Turbid water and some organic solids squeezed out	Recognizable but vague, difficult to identify	
H6	Turbid water; 1/3 of sample squeezed out	Indistinct, pasty	
H7	Very turbid water; ½ of sample squeezed out	Faintly recognizable; few remains identifiable, mostly amorphous	Sapric
H8	Thick and pasty; 2/3 of sample squeezed out	Very indistinct	
H9	No free water; nearly all of sample squeezed out	No identifiable remains	
H10	No free water; all of sample squeezed out	Completely amorphous	

Iron Reduction, Translocation, and Accumulation

Saturated or inundated soils. In an anaerobic environment, soil microbes reduce ferric iron (Fe^{+3}) to ferrous iron (Fe^{+2}). Areas in the soil where iron is reduced often develop characteristic bluish-gray or greenish-gray colors known as *gley*. Ferric iron is insoluble but ferrous iron easily enters the soil solution. Iron that is reduced in some areas of the soil enters into the soil solution and is moved or translocated to other areas of the soil. Areas that have lost iron typically develop characteristic whitish-gray or reddish-gray colors and are known as *redox depletions.* If a soil reverts to an aerobic state, iron that is in solution will oxidize and become concentrated in patches and along pores and root channels. These areas of oxidized iron are called *redox concentrations.* Since water movement in these saturated or inundated soils can be multi-directional, redox depletions and concentrations can occur anywhere in the soil and have irregular shapes and sizes.

Sulfate Reduction

Sulfur is one of the last elements to be reduced by microbes in an anaerobic environment. The microbes convert SO_4^{-2} to H_2S, or hydrogen sulfide. This results in a very pronounced "rotten egg" odor in some soils that are inundated or saturated for very long periods. In non-saturated or non-inundated soils, sulfate is not reduced and there is no rotten egg odor.

Cautions

A soil that is artificially drained or protected (for instance, by levees) is still hydric if the soil in its undisturbed state would meet the definition of a hydric soil. To be determined hydric, these soils should generally have one or more of the indicators.

Morphological features that do not reflect contemporary or recent conditions of saturation and anaerobiosis are called relict features. Typically, contemporary and recent hydric soil features have diffuse boundaries; relict hydric soil features have abrupt boundaries (Vepraskas 1992). Additional guidance for some of the most common problem hydric soils can be found in Chapter 5. When soil morphology seems inconsistent with the landscape, vegetation, or observable hydrology, it may be necessary to obtain the assistance of an experienced soil or wetland scientist to determine whether the soil is hydric.

Procedures for Sampling Soils

Observe and Document the Site

The common temptation is to excavate a small hole in the soil, note the presence of any indicators, make a decision, and leave. Before any decision can be made, however, the overall site and how it interacts with the soil must be understood and documented.

At each site, examine and describe on the data form the site features listed below before looking for hydric soil indicators. If one or more of the hydric soil indicators given later in this chapter is present, then the soil is hydric. Use the additional information below to understand why the soil is hydric. If no hydric soil indicators are present, use the additional site information to determine if the soil is indeed non-hydric or if it might represent a “problem” hydric soil.

- *Hydrology*–Is standing water observed on the site or is water observed in the soil pit? What is the depth of the water table in the area? Is there indirect evidence of ponding or flooding?

- *Slope*–Is the site level or nearly level so that surface water does not run off readily, or is it steeper where surface water would run off from the soil?

- *Slope shape*–Is the surface concave (e.g., depressions), where water would tend to collect and possibly pond on the soil surface? Is it flat, where water would not readily run off? On hillsides, are there convergent slopes, where surface or groundwater may be directed toward a central stream or swale? Or is the surface or slope shape convex, causing water to run off or disperse?

- *Landform*–Is the soil on a low terrace or floodplain that may be subject to seasonal high water tables or flooding? Is it at the toe of a slope where runoff may tend to collect or groundwater emerge at or near the surface? Has the microtopography been altered by cultivation?

- *Soil materials*–Is there a restrictive layer in the soil that would slow or prevent the infiltration of water? This could include consolidated bedrock, cemented layers such as duripans and petrocalcic horizons, layers of silt or substantial clay content, or strongly contrasting soil textures (e.g., silt over sand). Or is there relatively loose soil material (sand, gravel, or rocks) or fractured bedrock that would allow the water to flow laterally down slope?

- *Vegetation*–Does the vegetation at the site indicate wetter conditions than at other nearby sites, or is it similar to what is found at nearby upland sites?

The questions above should be considered at any site. Always look at the landscape features of the immediate site and compare them to the surrounding areas. Try to contrast the features of wet and dry sites that are in close proximity. When observing slope features, look first at the area immediately around the sampling point. For example, a nearly level bench or depression at the sampling point may be more important to site wetness than the overall landform on which it occurs. By understanding how water moves across the site, the reasons for the presence or absence of hydric soil indicators should be clear.

Observe and Document the Soil

To document a hydric soil, first remove any loose leaves, needles, or bark from the soil surface. Do not remove the organic surface layers of the soil, which usually consist of plant remains in varying stages of decomposition. Dig a hole and describe the soil profile to a recommended depth of approximately 20 in. (50 cm) from the soil surface. Digging may be difficult in some areas due to rocks and hardpans. Use the completed profile description to determine which indicators have been matched (USDA Natural Resources Conservation Service 2006b).

In general, the hole should be dug to the depth needed to document an indicator or to confirm the absence of indicators. Deeper examination of the soil may be required when field indicators are not easily seen within 20 in. (50 cm) of the surface. For example, examination to less than 20 in. (50 cm) may suffice in soils with surface horizons of saturated organic material or mucky mineral material (e.g., indicator A2 – Histic Epipedon). Conversely, depth of excavation will often need to be greater than 20 in. (50 cm) in soils with thick dark surface horizons because the upper horizons of these soils, due to the masking effect of organic material, often contain no easily visible redoximorphic features. At some sites, it is necessary to make exploratory observations to 40 in. (1 m) or more (e.g., indicator A12 – Thick Dark Surface). These observations should be made with the intent of documenting and understanding the variability in soil properties and hydrologic relationships on the site.

Whenever possible, excavate the soil deep enough to determine if there are layers or materials present that might restrict soil drainage. This will help to understand why the soil may or may not be hydric. Consider taking photographs of both the soil and the overall site.

Depths used in the indicators are measured from the muck surface, or from the mineral soil surface if a muck surface is absent. For indicators A1 (Histosols), A2 (Histic Epipedon), and A3 (Black Histic), depths are measured from the top of the organic material (peat, mucky peat, or muck). All colors noted in this supplement refer to moist Munsell® colors (Gretag/Macbeth 2000). Soil colors specified in the indicators do not have decimal points; however, intermediate colors do occur between Munsell chips. Soil chroma should not be rounded to qualify as meeting an indicator. For example, a soil matrix with a chroma between 2 and 3 should be listed as having a chroma of 2+. This soil material does not have a chroma of 2 and would not meet any indicator that requires a chroma of 2 or less. Always examine soil colors in the field immediately after sampling. Ferrous iron, if present, can oxidize rapidly and create colors of higher chroma or redder hue.

Particular attention should be paid to changes in microtopography over short distances. Small changes in elevation may result in repetitive sequences of hydric/non-hydric soils, making the delineation of individual areas of hydric and non-hydric soils difficult. Often the dominant condition (hydric or non-hydric) is the only reliable interpretation. The shape of the local landform can greatly affect the movement of water through the landscape. Significant changes in parent material or lithologic discontinuities in the soil can affect the hydrologic properties of the soil. After a sufficient number of exploratory excavations have been made to understand the soil-hydrologic relationships at the site, subsequent excavations can be limited to the depth needed to identify hydric soil indicators.

Hydric Soil Indicators

Many of the hydric soil indicators were developed specifically for wetland-delineation purposes. During the development of these indicators, soils in the interior of wetlands were not always examined; therefore, there are wetlands that lack any of the approved hydric soil indicators in the wettest interior portions. Wetland delineators and other users of the hydric soil indicators should concentrate their sampling efforts near the wetland edge and, if these soils are hydric, assume that soils in the interior of the wetland are also hydric even if they lack an indicator.

Hydric soil indicators are presented in three groups. Indicators for "All Soils" are used in any soil regardless of texture. Indicators for "Sandy Soils" are used in soil layers with USDA textures of loamy fine sand or coarser. Indicators for "Loamy and Clayey Soils" are used with soil layers of loamy very fine sand and finer. Both sandy and loamy/clayey layers may be present in the same soil profile.

All Soils

"All soils" refers to soils with any USDA soil texture. Use the following indicators regardless of soil texture.

Unless otherwise indicated, all mineral layers above any of the indicators must have a dominant chroma of 2 or less, or the layer(s) with dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Indicator A1: Histosol

Technical Description: Classifies as a Histosol (except Folists)

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: In a Histosol, 16 in. (40 cm) or more of the upper 32 in. (80 cm) is organic soil material (Figure 3-1). Organic soil material has an organic carbon content (by weight) of 12 to 18 percent or more, depending on the clay content of the soil. The material includes muck (sapric soil material), mucky peat (hemic soil material), or peat (fibric soil material). See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) for definitions of muck, mucky peat, peat, and organic soil material. See the Concepts section of this chapter for field methods to identify organic soil materials.

This indicator most often occurs in slope or groundwater-discharge wetlands in glaciated landscapes in LRR E and in depressional wetlands in LRR A that are almost always saturated to the soil surface.

Figure 3-1. Indicator A1 (Histosols). In this example, muck (sapric soil material) is greater than 3 ft (0.9 m) thick.

Indicator A2: Histic Epipedon

Technical Description: A histic epipedon underlain by mineral soil material with chroma of 2 or less.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: Most histic epipedons are surface horizons 8 in. (20 cm) or more thick of organic soil material (Figure 3-2). Aquic conditions or artificial drainage are required (see *Soil Taxonomy*, USDA Natural Resources Conservation Service 1999); however, aquic conditions can be assumed if indicators of hydrophytic vegetation and wetland hydrology are present. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) for definitions. See the Concepts section of this chapter for field methods to identify organic soil materials. See indicator A1 for organic carbon requirements. Slightly lower organic carbon contents are allowed in plowed soils. This indicator is often found in wet meadows in LRR E, depressional areas, or slope wetlands that are almost always saturated to the soil surface.

Figure 3-2. Organic surface layer less than 16 in. (40 cm) thick.

Indicator A3: Black Histic

Technical Description: A layer of peat, mucky peat, or muck 8 in. (20 cm) or more thick that starts within 6 in. (15 cm) of the soil surface; has hue of 10YR or yellower, value of 3 or less, and chroma of 1 or less; and is underlain by mineral soil material with chroma of 2 or less (Figure 3-3).

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: This indicator does not require proof of aquic conditions or artificial drainage. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) for definitions of peat, mucky peat, and muck. See the Concepts section of this chapter for field methods to identify organic soil materials. See indicator A1 for organic carbon requirements. This indicator is rare in this region.

Figure 3-3. Black organic surface layer greater than 11 in. (28 cm) thick.

Indicator A4: Hydrogen Sulfide

Technical Description: A hydrogen sulfide (rotten egg) odor within 12 in. (30 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: Any time the soil smells of hydrogen sulfide (rotten egg odor), sulfur is currently being reduced and the soil is definitely in an anaerobic state. In some soils, the odor is well-pronounced; in others it is very fleeting as the gas dissipates rapidly. If in doubt, quickly open several small holes in the area of concern to determine if a hydrogen sulfide odor is really present. This indicator is most commonly found in areas that are permanently saturated or inundated and is almost never found at the wetland/non-wetland boundary. It can sometimes be found in fringe wetlands adjacent to lakes.

Indicator A11: Depleted Below Dark Surface

Technical Description: A layer with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less, starting within 12 in. (30 cm) of the soil surface, and having a minimum thickness of either:

- 6 in. (15 cm), or
- 2 in. (5 cm) if the 2 in. (5 cm) consists of fragmental soil material.

Loamy/clayey layer(s) above the depleted or gleyed matrix must have value of 3 or less and chroma of 2 or less. Any sandy material above the depleted or gleyed matrix must have value of 3 or less and chroma of 1 or less, and at least 70 percent of the visible soil particles must be covered, coated or similarly masked with organic material.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: This indicator often occurs in grassland soils (Mollisols), but also applies to other soils that have dark-colored surface layers, such as umbric epipedons and dark-colored ochric epipedons (Figure 3-6). For soils that have dark surface layers greater than 12 in. (30 cm) thick, use indicator A12. Two percent or more distinct or prominent redox concentrations, including iron/manganese soft masses, pore linings, or both, are required in soils that have matrix value/chroma of 4/1, 4/2, and 5/2 (Figure A1). See the Glossary (Appendix A) for definitions of depleted matrix, gleyed matrix, distinct and prominent features, and fragmental soil material.

In some places, the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of a gleyed matrix (USDA Natural Resources Conservation Service 2002).

This indicator is commonly found at the boundary of wetlands in Mollisols or other dark-colored soils.

Figure 3-6. Depleted matrix starts immediately below the black surface layer (approximately 10 in. (25 cm)).

Indicator A12: Thick Dark Surface

Technical Description: A layer at least 6 in. (15 cm) thick with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less starting 12 in. (30 cm) or more below the surface. The layer(s) above the depleted or gleyed matrix must have value of 2.5 or less and chroma of 1 or less to a depth of at least 12 in. (30 cm) and value of 3 or less and chroma of 1 or less in any remaining layers above the depleted or gleyed matrix. Any sandy material above the depleted or gleyed matrix must have at least 70 percent of the visible soil particles covered, coated, or similarly masked with organic material.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: The soil has a depleted matrix or gleyed matrix below a black or very dark gray surface layer 12 in. (30 cm) or more thick (Figure 3-7). This indicator is most often associated with overthickened soils in concave landscape positions. Two percent or more distinct or prominent redox concentrations (Table A1), including iron/manganese soft masses, pore linings, or both, are required in soils that have matrix value/chroma of 4/1, 4/2, and 5/2 (Figure A1). See the Glossary (Appendix A) for the definitions of depleted and gleyed matrix.

In some places, the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of a gleyed matrix (USDA Natural Resources Conservation Service 2002).

This indicator is less common than indicators A11 (Depleted Below Dark Surface), F3 (Depleted Matrix), and F6 (Redox Dark Surface).

Figure 3-7. Deep observations may be necessary to identify the depleted or gleyed matrix below the dark surface layer.

Sandy Soils

"Sandy soils" refers to soil materials with a USDA soil texture of loamy fine sand and coarser. Use the following indicators in soil layers consisting of sandy soil materials.

Unless otherwise indicated (e.g., see indicator S6 – Stripped Matrix), all mineral layers above any of the indicators must have a dominant chroma of 2 or less, or the layer(s) with dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Indicator S1: Sandy Mucky Mineral

Technical Description: A layer of mucky modified sandy soil material 2 in. (5 cm) or more thick starting within 6 in. (15 cm) of the soil surface (Figure 3-8).

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: *Mucky* is a USDA texture modifier for mineral soils. The organic carbon content is at least 5 percent and ranges to as high as 14 percent for sandy soils. The percentage requirement is dependent upon the clay content of the soil; the higher the clay content, the higher the organic carbon requirement. See the glossary of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b) for the definition of mucky modified mineral texture. A field procedure for identifying mucky mineral soil material is presented in the Concepts section of this chapter.

This indicator is common in swales associated with coastal sand dunes in LRR A. This indicator is of limited extent in LRR E but, where it occurs, is often found at the wetland/non-wetland boundary.

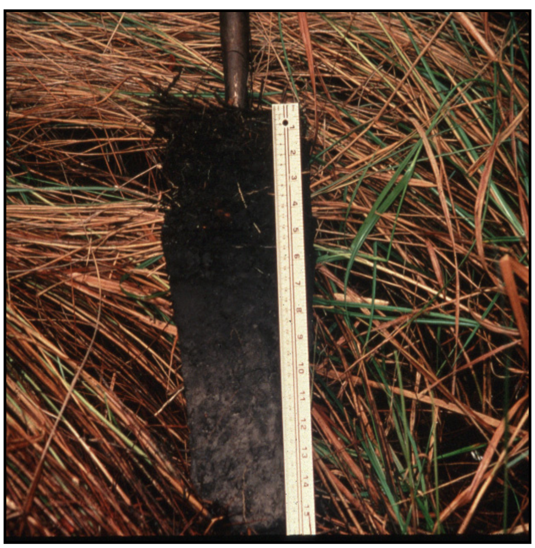

Figure 3-8. The mucky modified sandy layer is approximately 3 in. (7.5 cm) thick. Scale in inches on the right side of ruler.

Indicator S4: Sandy Gleyed Matrix

Technical Description: A gleyed matrix that occupies 60 percent or more of a layer starting within 6 in. (15 cm) of the soil surface (Figure 3-9).

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: The gleyed matrix only has to be present within 6 in. (15 cm) of the surface. Soils with gleyed matrices are saturated for significant periods; therefore, no minimum thickness of gleyed layer is required. See the Glossary (Appendix A) for the definition of a gleyed matrix.

This indicator is rare in the Western Mountains, Valleys and Coast Region and is only found in sandy soils that are almost continuously saturated.

Figure 3-9. In this example, the gleyed matrix begins at the soil surface.

Indicator S5: Sandy Redox

Technical Description: A layer starting within 6 in. (15 cm) of the soil surface that is at least 4 in. (10 cm) thick and has a matrix with 60 percent or more chroma of 2 or less with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings (Figure 3-10).

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: Distinct and prominent are defined in the Glossary (Appendix A). Redox concentrations include iron and manganese masses (reddish mottles) and pore linings (Vepraskas 1992). Included within the concept of redox concentrations are iron/manganese bodies as soft masses with diffuse boundaries. Common (2 to less than 20 percent) to many (20 percent or more) redox concentrations (USDA Natural Resources Conservation Service 2002) are required.

For sandy soils in LRR E, this is the most common indicator for identifying the wetland/non-wetland boundary.

Figure 3-10. In this soil, redox features begin at about 2 in. (5 cm).

Indicator S6: Stripped Matrix

Technical Description: A layer starting within 6 in. (15 cm) of the soil surface in which iron/manganese oxides and/or organic matter have been stripped from the matrix and the primary base color of the soil material has been exposed. The stripped areas and translocated oxides and/or organic matter form a faint, diffuse splotchy pattern of two or more colors. The stripped zones are 10 percent or more of the volume; they are rounded and approximately 0.5 to 1 in. (1 to 3 cm) in diameter.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: This indicator includes the indicator previously named streaking (Environmental Laboratory 1987). Common to many (USDA Natural Resources Conservation Service 2002) areas of stripped (uncoated) soil materials 0.5 to 1 in. (1 to 3 cm) in size are required, but they may be smaller. Commonly, the splotches of color have value 5 or more and chroma 1 and/or 2 (stripped) and chroma 3 and/or 4 (unstripped). However, there are no specific color requirements for this indicator. The mobilization and translocation of the oxides and/or organic matter is the important process and should result in splotchy coated and uncoated soil areas. A 10-power hand lens can be helpful in seeing stripped and unstripped areas.

This indicator is very common at the wetland/non-wetland boundary in dune/swale complexes in western Oregon and in depressional areas in sandy outwash.

Figure 3-11. The layer stripped of organic matter begins beneath the dark surface layer (approximately 2 in. (5 cm)).

Loamy and Clayey Soils

"Loamy and clayey soils" refers to soil materials with USDA textures of loamy very fine sand and finer. Use the following indicators in soil layers consisting of loamy or clayey soil materials.

Unless otherwise indicated (e.g., see Indicator F8 – Redox Depressions), all mineral layers above any of the indicators must have a dominant chroma of 2 or less, or the layer(s) with dominant chroma of more than 2 must be less than 6 in. (15 cm) thick to meet any hydric soil indicator. Nodules and concretions are not considered to be redox concentrations unless otherwise noted.

Indicator F1: Loamy Mucky Mineral

Technical Description: A layer of mucky modified loamy or clayey soil material 4 in. (10 cm) or more thick starting within 6 in. (15 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region (except for MLRA 1 (Northern Pacific Coast Range) in LRR A).

User Notes: *Mucky* is a USDA texture modifier for mineral soils. The organic carbon is at least 8 percent, but can range to as high as 18 percent. The percentage requirement is dependent upon the clay content of the soil; the higher the clay content, the higher the organic carbon requirement. See the Concepts section of this chapter for guidance on identifying mucky mineral soil materials in the field; however, loamy mucky soil material is difficult to distinguish without laboratory testing.

Indicator F2: Loamy Gleyed Matrix

Technical Description: A gleyed matrix that occupies 60 percent or more of a layer starting within 12 in. (30 cm) of the soil surface (Figure 3-12).

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: Gley colors are not synonymous with gray colors. Gley colors are those colors that are on the gley pages (Gretag/Macbeth 2000). They have hue N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB, with value 4 or more. The gleyed matrix only has to be present within 12 in. (30 cm) of the surface. Soils with gleyed matrices are saturated for significant periods; therefore, no minimum thickness of gleyed layer is required. See the Glossary (Appendix A) for the definition of a gleyed matrix.

This indicator is almost never found at the wetland/non-wetland boundary.

Figure 3-12. This gleyed matrix begins at the soil surface.

Indicator F3: Depleted Matrix

Technical Description: A layer that has a depleted matrix with 60 percent or more chroma of 2 or less and that has a minimum thickness of either:

- 2 in. (5 cm) if 2 in. (5 cm) is entirely within the upper 6 in. (15 cm) of the soil, or
- 6 in. (15 cm) starting within 10 in. (25 cm) of the soil surface.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: This is the most common indicator found at the boundaries of wetlands. Redox concentrations including iron/manganese soft masses or pore linings, or both, are required in soils with matrix value/chroma of 4/1, 4/2, and 5/2 (Figures 3-13 and 3-14). Redox concentrations are not required for soils with matrix value 5 or more and chroma 1, or value 6 or more and chroma 2 or 1. The low chroma matrix must be caused by wetness and not a relict or parent material feature. See the Glossary (Appendix A) for the definition of a depleted matrix.

Figure 3-13. Indicator F3, Depleted Matrix. Redox concentrations are present within a low-chroma matrix.

Figure 3-14. Redox concentrations at 2 in. (5 cm).

Indicator F6: Redox Dark Surface

Technical Description: A layer that is at least 4 in. (10 cm) thick, is entirely within the upper 12 in. (30 cm) of the mineral soil, and has:

- Matrix value of 3 or less and chroma of 1 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings, or
- Matrix value of 3 or less and chroma of 2 or less and 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: This is a very common indicator used to delineate wetlands. Redox concentrations in high organic-content mineral soils with dark surfaces are often small and difficult to see (Figure 3-15). The organic matter masks some or all of the concentrations that may be present. Careful examination is required to see what are often brownish redox concentrations in the darkened materials. In some instances, drying of the samples makes the concentrations (if present) easier to see. A hand lens may be helpful in seeing and describing small redox concentrations. Care should be taken to examine the interior of soil peds for redox concentrations. Dry colors, if used, also need to have matrix chromas of 1 or 2, and the redox concentrations need to be distinct or prominent.

In soils that are wet because of subsurface saturation, the layer immediately below the dark epipedon will likely have a depleted or gleyed matrix (see the Glossary for definitions). Soils that are wet because of ponding or have a shallow, perched layer of saturation may not always have a depleted/gleyed matrix below the dark surface. This morphology has been observed in soils that have been compacted by tillage and other means. It is recommended that delineators evaluate the hydrologic source and examine and describe the layer below the dark-colored epipedon when applying this indicator.

Figure 3-15. Redox features can be small and difficult to see within a dark soil layer.

Indicator F7: Depleted Dark Surface

Technical Description: Redox depletions with value of 5 or more and chroma of 2 or less in a layer that is at least 4 in. (10 cm) thick, is entirely within the upper 12 in. (30 cm) of the mineral soil (Figure 3-16), and has:

- Matrix value of 3 or less and chroma of 1 or less and 10 percent or more redox depletions, or
- Matrix value of 3 or less and chroma of 2 or less and 20 percent or more redox depletions.

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: Care should be taken not to mistake the mixing of eluvial layers that have high value and low chroma (E horizon) or illuvial layers that have accumulated carbonates (calcic horizon) into the surface layer as depletions. The pieces of these layers are not redox depletions. Knowledge of local conditions is required in areas where light-colored eluvial layers and/or layers high in carbonates may be present. In soils that are wet because of subsurface saturation, the layer immediately below the dark surface is likely to have a depleted or gleyed matrix. Redox depletions will usually have associated microsites with redox concentrations that occur as pore linings or masses within the depletion(s) or surrounding the depletion(s).

This indicator is very rare in this region.

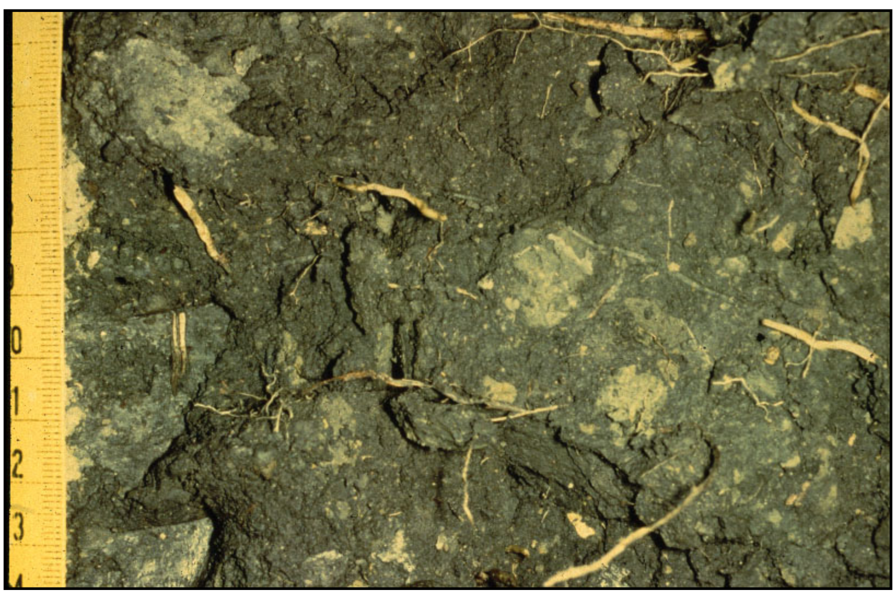

Figure 3-16. Redox depletions (lighter colored areas) scattered within the darker matrix.

Indicator F8: Redox Depressions

Technical Description: In closed depressions subject to ponding, 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings in a layer that is 2 in. (5 cm) or more thick and is entirely within the upper 6 in. (15 cm) of the soil (Figure 3-17).

Applicable Subregions: Applicable throughout the Western Mountains, Valleys and Coast Region.

User Notes: This indicator occurs on depressional landforms, such as vernal pools and potholes; but not microdepressions on convex landscapes. Closed depressions often occur within flats or floodplain landscapes. *Note that there is no color requirement for the soil matrix.* The layer containing redox concentrations may extend below 6 in. (15 cm) as long as at least 2 in. (5 cm) occurs within 6 in. (15 cm) of the surface. See the Glossary for definitions of distinct and prominent.

This is a common but often overlooked indicator found at the wetland/non-wetland boundary on depressional sites.

Figure 3-17. In this example, the layer of redox concentrations begins at the soil surface and is slightly more than 2 in. (5 cm) thick.

Hydric Soil Indicators for Problem Soils

The following indicators are not currently recognized for general application by the NTCHS, or they are not recognized in the specified geographic area. However, these indicators may be used in problem wetland situations in the Western Mountains, Valleys and Coast Region where there is evidence of wetland hydrology and hydrophytic vegetation, and the soil is believed to meet the definition of a hydric soil despite the lack of other indicators of a hydric soil. To use these indicators, follow the procedure described in the section on Problematic Hydric Soils in Chapter 5. If any of the following indicators is observed, it is recommended that the NTCHS be notified by following the protocol described in the "Comment on the Indicators" section of *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service 2006b).

Indicator A10: 2 cm Muck

Technical Description: A layer of muck 0.75 in. (2 cm) or more thick with value of 3 or less and chroma of 1 or less, starting within 6 in. (15 cm) of the soil surface.

Applicable Subregions: For use with problem soils throughout the Western Mountains, Valleys and Coast Region.

User Notes: Normally the muck layer is at the soil surface; however, it may occur at any depth within 6 in. (15 cm) of the surface. Muck is sapric soil material with at least 12 to 18 percent organic carbon. Organic soil material is called muck if virtually all of the material has undergone sufficient decomposition to limit recognition of the plant parts. Hemic (mucky peat) and fibric (peat) soil materials do not qualify. To determine if muck is present, first remove loose leaves, needles, bark, and other easily identified plant remains. This is sometimes called leaf litter, a duff layer, or a leaf or root mat. Then examine for decomposed organic soil material. Generally, muck is black and has a greasy feel; sand grains should not be evident (see the Concepts section of this chapter for field methods to identify organic soil materials). Determination of this indicator is made below the leaf or root mat; however, root mats that meet the definition of hemic or fibric soil material are included in the decision-making process for indicators A1 (Histosols) and A2 (Histic Epipedon).

Indicator TF2: Red Parent Material

Technical Description: In parent material with a hue of 7.5YR or redder, a layer at least 4 in. (10 cm) thick with a matrix value and chroma of 4 or less and 2 percent or more redox depletions and/or redox concentrations occurring as soft masses and/or pore linings. The layer is entirely within 12 in. (30 cm) of the soil surface. The minimum thickness requirement is 2 in. (5 cm) if the layer is the mineral surface layer.

Applicable Subregions: For use with problem soils throughout the Western Mountains, Valleys and Coast Region.

User Notes: Redox features that are most noticeable in red material include redox depletions and soft manganese masses that are black or dark reddish black.

Use of Existing Soil Data

Soil Surveys

Soil surveys are available for many areas of the Western Mountains, Valleys and Coast Region and can provide useful information regarding soil properties and soil moisture conditions for an area. Soil surveys in the region vary considerably, however, in the mapping scale and the amount of ground-truthing used to document the survey. A list of available soil surveys is located at http://soils.usda.gov/survey/online_surveys/ and soil maps and data are available online at http://websoilsurvey.nrcs.usda.gov/. Most detailed soil surveys in the region are mapped at a scale of 1:24,000 (2.64 in./mile). At this scale, the smallest soil areas delineated, called map units, are about 5 acres (2 ha) in size. Map units usually contain more than one soil type or component. They often contain several minor components or inclusions of soils with properties that may be similar to or quite different from the major component. Those soils that are hydric are noted in the *Hydric Soils List* published separately from the soil survey report. Soil survey information can be valuable for planning purposes, but it is not site-specific and does not preclude the need for an on-site investigation.

Hydric Soils Lists

Hydric Soils Lists are developed for each detailed soil survey. Using criteria approved by the National Technical Committee for Hydric Soils, these lists rate each soil component as either hydric or non-hydric based on soil property data. If the soil is rated as hydric, information is provided regarding which hydric criteria are met and on what landform the soil typically occurs. Hydric Soils Lists are useful as general background information for an on-site delineation. The hydric soils list should be used as a tool, indicating that hydric soil will likely be found within a given area. However, not all areas within a polygon identified as having hydric soils may be hydric.

Hydric Soils Lists developed for individual detailed soil surveys are known as Local Hydric Soils Lists. They are available from state or county NRCS offices and over the internet from the Soil Data Mart (http://soildatamart.nrcs.usda.gov/). Local Hydric Soils Lists have been compiled into a National Hydric Soils List available at http://soils.usda.gov/use/hydric/. However, use of Local Hydric Soils Lists is preferred since they are more current and reflect local variations in soil properties.

4 Wetland Hydrology Indicators

Introduction

Wetland hydrology indicators are used in combination with indicators of hydric soil and hydrophytic vegetation to determine whether an area is a wetland under the Corps Manual. Indicators of hydrophytic vegetation and hydric soil generally reflect a site's medium- to long-term wetness history. They provide readily observable evidence that episodes of inundation or soil saturation lasting more than a few days during the growing season have occurred repeatedly over a period of years and that the timing, duration, and frequency of wet conditions have been sufficient to produce a characteristic wetland plant community and hydric soil morphology. If hydrology has not been altered, vegetation and soils provide the strongest evidence that wetland hydrology is present (National Research Council 1995). Wetland hydrology indicators provide evidence that the site has a *continuing* wetland hydrologic regime and that hydric soils and hydrophytic vegetation are not relicts of a past hydrologic regime. Wetland hydrology indicators confirm that an episode of inundation or soil saturation occurred recently, but may provide little additional information about the timing, duration, or frequency of such events (National Research Council 1995).

Hydrology indicators are often the most ephemeral of wetland indicators. Those involving direct observation of surface water or saturated soils are usually present only during the normal wet portion of the growing season and may be absent during the dry season or during drier-than-normal years. The climate of the Western Mountains, Valleys and Coast Region is spatially highly diverse due to variations in latitude and elevation, and rain-shadow effects. In general, average annual precipitation increases toward the north and west. In the higher mountains, much of the precipitation falls as snow and is released during spring thaw. Summers in the interior are often hot and dry. Along the northwest coast, the summer dry season is ameliorated somewhat by fog (Bailey 1995). During the annual dry season, some wetlands in the region may lack hydrology indicators. However, the lack of an indicator is not evidence for the absence of wetland hydrology. See Chapter 5 (Difficult Wetland Situations in the Western Mountains, Valleys and Coast Region) for help in identifying wetlands that may lack wetland hydrology indicators during dry periods. On the other hand, some indicators may be present on non-wetland sites immediately after a heavy rain or during periods of unusually high precipitation, river stages, runoff, or snowmelt. Therefore, it is important to take weather conditions prior to the site visit into account to minimize both false-positive and false-negative wetland hydrology decisions. An understanding of normal seasonal and annual variations in rainfall, temperature, and other climatic conditions is essential in interpreting hydrology indicators in the region. Some useful sources of climatic data are described in Chapter 5.

Areas that have hydrophytic vegetation and hydric soils generally also have wetland hydrology unless the hydrologic regime has changed due to natural events or human activities (National Research Council 1995). Therefore, when wetland hydrology indicators are absent from an area that has indicators of hydric soil and hydrophytic vegetation, further information may be needed to determine whether or not wetland hydrology is present. If possible, one or more site visits should be scheduled to coincide with the normal wet portion of the growing season, the period of the year when the presence or absence of wetland hydrology indicators is most likely to reflect the true wetland/non-wetland status of the site. In addition, aerial photography or remote sensing data, stream gauge data, runoff estimates, scope-and-effect equations for ditches and subsurface drain lines, or groundwater modeling are tools that may help to determine whether wetland hydrology is present when indicators are equivocal or lacking (e.g., USDA Natural Resources Conservation Service 1997). Off-site procedures developed under the National Food Security Act Manual (USDA Natural Resources Conservation Service 1994), which use wetland mapping conventions developed by NRCS state offices, can help identify areas that have wetland hydrology on agricultural lands. The technique is based on wetness signatures visible on standard high-altitude aerial photographs or on annual crop-compliance slides taken by the USDA Farm Service Agency. Finally, on highly disturbed or problematic sites, direct hydrologic monitoring may be needed to determine whether wetland hydrology is present. The U. S. Army Corps of Engineers (2005) provides a technical standard for monitoring hydrology on such sites. This standard requires 14 or more consecutive days of flooding or ponding, or a water table 12 in. (30 cm) or less below the soil surface, during the growing season at a minimum frequency of 5 years in 10 (50 percent or higher probability) (National Research Council 1995). See Chapter 5 for further information on these techniques.

Growing Season

Beginning and ending dates of the growing season are needed to evaluate certain wetland indicators, such as visual observations of flooding, ponding, or shallow water tables on potential wetland sites. In addition, growing season dates are needed in the event that recorded hydrologic data, such as stream gauge or water-table monitoring data, must be analyzed to determine whether wetland hydrology is present on highly disturbed or problematic sites.

For convenience nationwide or in the absence of site-specific information, the U.S. Army Corps of Engineers (2005) recommends a procedure for estimating growing season dates based on the median dates (i.e., 5 years in 10, or 50 percent probability) of 28 °F (-2.2 °C) air temperatures in spring and fall, based on long-term records gathered at National Weather Service meteorological stations. These dates are reported in WETS tables available from the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html) for the nearest appropriate weather station. However, this approach is often impractical in mountainous areas due to differences in elevation, aspect, and other conditions between project sites and the location of the nearest weather station. Therefore, site-specific alternative approaches are often needed to determine the start of the growing season in a given year.

Depletion of oxygen and the chemical reduction of nitrogen, iron, and other elements in saturated soils is the result of biological activity, both plant roots and soil microbial populations (National Research Council 1995). Two indicators of biological activity that are readily observable in the field are (1) above-ground growth and development of vascular plants and (2) soil temperature. Therefore, at the discretion of the appropriate Corps of Engineers District, one or both of the following approaches may be used in the region to determine the start of the growing season on a particular project site. The growing season has begun if either of these conditions is met. The ending date of the growing season shall continue to be based on the 28 °F air temperature threshold as reported in WETS tables.

1. The growing season has begun on a site in a given year when two or more different non-evergreen vascular plant species growing in the wetland or surrounding areas exhibit one or more of the following indicators of biological activity:

    a. Emergence of herbaceous plants from the ground

b. Appearance of new growth from vegetative crowns (e.g., in graminoids, bulbs, and corms)
c. Coleoptile/cotyledon emergence from seed
d. Bud burst on woody plants (e.g., some green foliage showing between spreading scales)
e. Emergence or elongation of leaves of woody plants
f. Emergence or opening of flowers

This determination should not include evergreen species. Observations should be made in the wetland or in surrounding areas subject to the same climatic conditions (e.g., similar elevation and aspect); however, soil moisture conditions may differ. Supporting data should be reported on the data form, in field notes, or in the delineation report, and should include the species observed (if identifiable), their abundance and location relative to the potential wetland, and type of biological activity observed. In addition, the observed growing season date should be discussed in relation to the median date of 28 °F air temperatures in spring as reported in WETS tables for the nearest appropriate weather station.

2. The growing season has begun in spring when soil temperature measured at 12 in. (30 cm) depth is 41 °F (5 °C) or higher. A one-time temperature measurement is sufficient, but not required, for evaluation of wetland hydrology indicators during a single site visit. However, if long-term hydrologic monitoring is planned, then soil temperature should be monitored to ensure that it remains continuously at or above 41 °F into the spring and summer. Soil temperature can be measured directly in the field by inserting a soil thermometer into the wall of a freshly dug soil pit. Growing season observations based on soil temperature should be discussed in relation to the median date of 28 °F air temperatures in spring as reported in WETS tables.

Wetland Hydrology Indicators

In this chapter, wetland hydrology indicators are presented in four groups. Indicators in Group A are based on the direct observation of surface water or groundwater during a site visit. Group B consists of evidence that the site is subject to flooding or ponding, although the site may not be inundated currently. These indicators include water marks, drift deposits, sediment deposits, and similar features. Group C consists of indirect evidence that the soil was saturated recently. Some of these indicators, such as oxidized rhizospheres surrounding living roots and the presence of reduced iron or sulfur in the soil profile, indicate that the soil has been saturated for an extended period. Group D consists of vegetation and soil features that indicate contemporary rather than historical wet conditions. Wetland hydrology indicators are intended as one-time observations of site conditions that are sufficient evidence of wetland hydrology in areas where hydric soils and hydrophytic vegetation are present. Most of the indicators are applicable throughout the Western Mountains, Valleys and Coast Region.

Within each group, indicators are divided into two categories – *primary* and *secondary* – based on their estimated reliability in this region. One primary indicator from any group is sufficient to conclude that wetland hydrology is present; the area is a wetland if indicators of hydric soil and hydrophytic vegetation are also present. In the absence of a primary indicator, two or more secondary indicators from any group are required to conclude that wetland hydrology is present. Indicators of wetland hydrology include, but are not necessarily limited to, those listed in Table 4-1 and described on the following pages. Other evidence of wetland hydrology may also be used with appropriate documentation.

Table 4-1. List of wetland hydrology indicators for the Western Mountains, Valleys and Coast Region

Indicator	Category	
	Primary	Secondary
Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water	X	
A2 – High water table	X	
A3 – Saturation	X	
Group B – Evidence of Recent Inundation		
B1 – Water marks	X	
B2 – Sediment deposits	X	
B3 – Drift deposits	X	
B4 – Algal mat or crust	X	
B5 – Iron deposits	X	
B6 – Surface soil cracks	X	
B7 – Inundation visible on aerial imagery	X	
B11 – Salt crust	X	
B13 – Aquatic invertebrates	X	
B9 – Water-stained leaves	X	X (NW Coast)
B8 – Sparsely vegetated concave surface		X
B10 – Drainage patterns		X
Group C – Evidence of Recent Soil Saturation		
C1 – Hydrogen sulfide odor	X	
C3 – Oxidized rhizospheres along living roots	X	
C4 – Presence of reduced iron	X	
C6 – Recent iron reduction in tilled soils	X	
C2 – Dry-season water table		X
C9 – Saturation visible on aerial imagery		X
Group D – Evidence from Other Site Conditions or Data		
D1 – Stunted or stressed plants	X (LRR A)	
D2 – Geomorphic position		X
D3 – Shallow aquitard		X
D4 – Frost-heave hummocks		X
D5 – FAC-neutral test		X
D6 – Raised ant mounds		X (LRR A)

Group A – Observation of Surface Water or Saturated Soils

Indicator A1: Surface water

Category: Primary

General Description: This indicator consists of the direct, visual observation of surface water (flooding or ponding) during a site visit (Figure 4-1).

Cautions and User Notes: Care must be used in applying this indicator because surface water may be present in non-wetland areas immediately after a rainfall event or during periods of unusually high precipitation, runoff, tides, or river stages. Furthermore, some non-wetlands flood frequently for brief periods. Surface water observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. If this is questionable and other hydrology indicators are absent, a follow-up visit during the growing season may be needed. Note that surface water may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., 50 percent or higher probability). In addition, groundwater-dominated wetland systems may never or rarely contain surface water.

Figure 4-1. Wetland with surface water present.

Indicator A2: High water table

Category: Primary

General Description: This indicator consists of the direct, visual observation of the water table 12 in. (30 cm) or less below the surface in a soil pit, auger hole, or shallow monitoring well (Figure 4-2). This indicator includes perched water tables and discharge water tables (e.g., in seeps) where water may enter the hole from the surface soil layers.

Cautions and User Notes: Sufficient time must be allowed for water to infiltrate into a newly dug hole and to stabilize at the water-table level. The required time will vary depending upon soil texture. In some cases, the water table can be determined by examining the wall of the soil pit and identifying the upper level at which water is seeping into the pit. A water table within 12 in. of the surface observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. If this is questionable and other hydrology indicators are absent, a follow-up visit during the growing season may be needed. Care must be used in interpreting this indicator because water-table levels normally vary seasonally and are a function of both recent and long-term precipitation. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., 50 percent or higher probability). For an accurate determination of the water-table level, the soil pit, auger hole, or well should not penetrate any restrictive soil layer capable of perching water near the surface.

Figure 4-2. High water table observed in a soil pit.

Indicator A3: Saturation

Category: Primary

General Description: Visual observation of saturated soil conditions 12 in. (30 cm) or less from the soil surface as indicated by water glistening on the surfaces and broken interior faces of soil samples removed from the pit or auger hole (Figure 4-3). This indicator must be associated with an existing water table located immediately below the saturated zone.

Cautions and User Notes: Glistening is evidence that the soil sample was taken either below the water table or within the saturated capillary fringe above the water table. Recent rainfall events and the proximity of the water table at the time of sampling must be considered in applying and interpreting this indicator. Water observed in soil cracks or on the faces of soil aggregates (peds) does not meet this indicator unless ped interiors are also saturated.

Figure 4-3. Water glistens on the surface of a saturated soil sample.

Group B – Evidence of Recent Inundation

Indicator B1: Water marks

Category: Primary

General Description: Water marks are discolorations or stains on the bark of woody vegetation, rocks, bridge pillars, buildings, fences, or other fixed objects as a result of inundation (Figure 4-4).

Cautions and User Notes: When several water marks are present, the highest reflects the maximum extent of recent inundation. Water marks indicate a water-level elevation and can be extrapolated from nearby objects across lower elevation areas. In regulated systems, such as reservoirs, water-level records can be used to distinguish unusually high pools from normal operating levels. Use caution with water marks that may have been caused by extreme, infrequent, or very brief flooding events. Stream flows in mountain and coastal areas tend to be more consistent than those in the Arid West. Therefore, water marks along mountain and northwest coastal streams are more likely to reflect typical high flows and water elevations in adjacent wetlands and, therefore, are assigned a primary status.

Figure 4-4. Water marks on a boulder.

Indicator B2: Sediment deposits

Category: Primary

General Description: Sediment deposits are thin layers or coatings of fine-grained mineral material (e.g., silt or clay) or organic matter (e.g., pollen), sometimes mixed with other detritus, remaining on tree bark (Figure 4-5), plant stems or leaves, rocks, and other objects after surface water recedes.

Cautions and User Notes: Sediment deposits most often occur in riverine backwater and ponded situations where water has stood for sufficient time to allow suspended sediment to settle. Sediment deposits may remain for a considerable period before being removed by precipitation or subsequent inundation. Sediment deposits on vegetation or other objects indicate the minimum inundation level. This level can be extrapolated across lower elevation areas. Use caution with sediment left after infrequent high flows or very brief flooding events. This indicator does not include thick accumulations of sand or gravel in fluvial channels that may reflect historic flow conditions or recent extreme events. Use caution in areas where silt and other material trapped in the snowpack may be deposited directly on the ground surface during spring thaw.

Figure 4-5. Silt deposit left after a recent high-water event forms a tan coating 2 ft (60 cm) high on these tree trunks.

Indicator B3: Drift deposits

Category: Primary

General Description: Drift deposits consist of rafted debris that has been deposited on the ground surface or entangled in vegetation or other fixed objects. Debris consists of remnants of vegetation (e.g., branches, stems, and leaves), man-made litter, or other waterborne materials. Drift material may be deposited at or near the high water line in ponded or flooded areas, piled against the upstream side of trees, rocks, and other fixed objects (Figure 4-6), or widely distributed within the dewatered area.

Cautions and User Notes: Deposits of drift material are often found adjacent to streams or other sources of flowing water in wetlands. They also occur in tidal marshes, along lake shores, and in other ponded areas. The elevation of a drift line can be extrapolated across lower elevation areas. Use caution with drift lines that may have been caused by extreme, infrequent, or very brief flooding events.

Figure 4-6. Drift deposit on the upstream side of a sapling in a floodplain wetland.

Indicator B4: Algal mat or crust

Category: Primary

General Description: This indicator consists of a mat or dried crust of algae, perhaps mixed with other detritus, left on or near the soil surface after dewatering.

Cautions and User Notes: Algal deposits include those produced by green algae (Chlorophyta) and blue-green algae (cyanobacteria). They may be attached to low vegetation or other fixed objects, or may cover the soil surface (Figures 4-7 and 4-8). Sometimes, dried threads of filamentous algae can be seen. Dried crusts of blue-green algae may crack and curl at plate margins (Figure 4-9). Algal deposits are most often seen in seasonally ponded depressions, interdunal swales, tidal areas, lake fringes, and low-gradient stream margins. They reflect prolonged wet conditions sufficient for algal growth and development.

Figure 4-7. Deposit of green algae in a seasonally inundated *Juncus* marsh.

Figure 4-8. Dark-colored material is benthic microflora consisting of blue-green and green algae in a hypersaline intertidal marsh.

Figure 4-9. Dried crust of blue-green algae on the soil surface.

Indicator B5: Iron deposits

Category: Primary

General Description: This indicator consists of a thin orange or yellow crust or gel of oxidized iron on the soil surface, or on objects near the surface, left behind after surface water recedes.

Cautions and User Notes: Iron deposits form in areas where reduced iron discharges with groundwater and oxidizes upon exposure to air. The oxidized iron forms a film or sheen on standing water (Figure 4-10) and an orange or yellow deposit (Figure 4-11) on the ground surface after dewatering.

Figure 4-10. Iron sheen on the water surface may be deposited as an orange or yellow crust after dewatering.

Figure 4-11. Iron deposit (orange area) in a dewatered channel.

Indicator B6: Surface soil cracks

Category: Primary

General Description: Surface soil cracks consist of shallow cracks that form when fine-grained mineral or organic sediments dry and shrink, often creating a network of cracks or small polygons (Figure 4-12).

Cautions and User Notes: Surface soil cracks are often seen in fine sediments in seasonally ponded depressions, lake fringes, and floodplains. Use caution, however, as they may also occur in temporary ponds and puddles in non-wetlands. This indicator does not include deep cracks due to shrink-swell action in Vertic soils.

Figure 4-12. Surface soil cracks in a seasonally ponded wetland.

Indicator B7: Inundation visible on aerial imagery

Category: Primary

General Description: One or more recent aerial photographs or satellite images show the site to be inundated (Figure 4-13).

Cautions and User Notes: Care must be used in applying this indicator because surface water may be present on a non-wetland site immediately after a heavy rain or during periods of unusually high precipitation, runoff, tides, or river stages. See Chapter 5 for procedures to evaluate the normality of precipitation. Surface water observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. Surface water may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., 50 percent or higher probability). If 5 or more years of aerial photography are available, the procedure described by the USDA Natural Resources Conservation Service (1997, section 650.1903) is recommended (see Chapter 5, section on Wetlands that Periodically Lack Indicators of Wetland Hydrology, for additional information).

Figure 4-13. Aerial view showing inundated areas.

Indicator B11: Salt crust

Category: Primary

General Description: Salt crusts are hard or brittle deposits of salts formed on the ground surface due to the evaporation of saline surface water.

Cautions and User Notes: Hard or brittle salt crusts form in ponded depressions, seeps, and lake fringes when saline surface waters evaporate (Jones 1965, Boettinger 1997) (Figure 4-14). They may form a white ring at the high water line as the water recedes. Salt crusts are also seen in areas of geothermal activity. Salt crusts do not include fluffy salt deposits or efflorescences resulting from capillary rise and evaporation of saline groundwater that may be derived from a deep water table.

Figure 4-14. A hard salt crust in a dry temporary pool (25-cent coin for scale).

Indicator B13: Aquatic invertebrates

Category: Primary

General Description: Presence of numerous live individuals, diapausing insect eggs or crustacean cysts, or dead remains of aquatic invertebrates, such as clams, snails, insects, ostracods, shrimp, and other crustaceans on the soil surface (Figures 4-15 and 4-16).

Cautions and User Notes: Examples of dead remains include clam valves, chitinous exoskeletons, insect head capsules, and aquatic snail shells. Invertebrates or their remains should be reasonably abundant; one or two individuals are not sufficient. Use caution in areas where invertebrate remains may have been transported by high winds or flowing water into non-wetland areas. Shells and exoskeletons are resistant to tillage but may be moved by equipment beyond the boundaries of the wetland. They may also persist in the soil for years after dewatering.

Figure 4-15. Shells of aquatic snails in a seasonally ponded fringe wetland.

Figure 4-16. Carapaces of tadpole shrimp (*Triops* sp.) and clam shrimp (*Leptestheria compleximanus*) in dried sediments of an ephemeral pool. Photo by Brian Lang (New Mexico Dept. of Game & Fish).

Indicator B9: Water-stained leaves

Category: Primary (Secondary along the Pacific coast (MLRA 1, 2, 4A, and 4B))

General Description: Water-stained leaves are fallen leaves that have turned grayish or blackish in color due to inundation for long periods.

Cautions and User Notes: Water-stained leaves are usually found in depressional wetlands and along streams in shrub-dominated or forested habitats. Staining occurs in leaves that are in contact with the soil surface while inundated for long periods. Water-stained leaves maintain their blackish or grayish colors when dry. They should contrast strongly with fallen leaves in nearby non-wetland landscape positions. In the very wet climate of coastal California, Oregon, and Washington, water-stained leaves are less likely to be restricted to wetland areas. Therefore, they are a secondary indicator in MLRA 1 (Northern Pacific Coast Range, Foothills, and Valleys), 2 (Willamette and Puget Sound Valleys), 4A (Sitka Spruce Belt), and 4B (Coastal Redwood Belt) (USDA Natural Resources Conservation Service 2006a).

Indicator B8: Sparsely vegetated concave surface

Category: Secondary

General Description: On concave land surfaces (e.g., depressions and swales), the ground surface is either unvegetated or sparsely vegetated (less than 5 percent ground cover) due to long-duration ponding during the growing season (Figure 4-17).

Cautions and User Notes: Ponding during the growing season can limit the establishment and growth of ground-layer vegetation. Sparsely vegetated concave surfaces should contrast with vegetated slopes and convex surfaces in the same area. A woody overstory of trees or shrubs may or may not be present.

Figure 4-17. A sparsely vegetated, seasonally ponded depression.

Indicator B10: Drainage patterns

Category: Secondary

General Description: This indicator consists of flow patterns visible on the soil surface or eroded into the soil, low vegetation bent over in the direction of flow, absence of leaf litter or small woody debris due to flowing water, and similar evidence that water flowed across the ground surface.

Cautions and User Notes: Drainage patterns are usually seen in areas where water flows broadly over the surface and is not confined to a channel, such as in areas adjacent to streams (Figure 4-18), in seeps, vegetated swales, and tidal flats. Use caution in areas subject to high winds or affected by recent extreme or unusual flooding events. Similar patterns may also be caused by snowmelt on non-wetland mountain slopes.

Figure 4-18. Vegetation bent over in the direction of water flow across a stream terrace.

Group C – Evidence of Recent Soil Saturation

Indicator C1: Hydrogen sulfide odor

Category: Primary

General Description: A hydrogen sulfide (rotten egg) odor within 12 in. (30 cm) of the soil surface.

Cautions and User Notes: Hydrogen sulfide is a gas produced by soil microbes in response to prolonged soil saturation. It is sometimes detected in mountain bogs, saline and brackish tidal marshes, and other wet habitats. For hydrogen sulfide to be detectable, the soil must be saturated at the time of sampling and must have been saturated long enough to become highly reduced. These soils are often permanently saturated and anoxic at or near the surface. To apply this indicator, dig the soil pit no deeper than 12 in. to avoid release of hydrogen sulfide from deeper in the profile. Hydrogen sulfide odor serves as both an indicator of hydric soil and wetland hydrology. This one observation proves that the soil meets the definition of a hydric soil (i.e., anaerobic in the upper part), plus has an ongoing wetland hydrologic regime. Often these soils have a high water table (wetland hydrology indicator A2), but the hydrogen sulfide odor provides further proof that the soil has been saturated for a long time.

Indicator C3: Oxidized rhizospheres along living roots

Category: Primary

General Description: This indicator consists of iron oxide coatings or plaques on the surfaces of living roots and/or iron oxide coatings or linings on soil pores immediately surrounding living roots within 12 in. (30 cm) of the soil surface and occupying at least 2 percent of the volume of the soil layer (Figure 4-19).

Cautions and User Notes: Oxidized rhizospheres are the result of oxygen leakage from living roots into the surrounding anoxic soil, causing oxidation of ferrous iron present in the soil solution. They are evidence of saturated and reduced soil conditions during the plant's lifetime. Iron concentrations or plaques may form on the immediate root surface or may coat the soil pore adjacent to the root. In either case, the oxidized iron must be associated with living roots to indicate contemporary wet conditions and to distinguish these features from other pore linings. Care must be taken to distinguish iron oxide coatings from organic matter associated with plant roots. Viewing with a hand lens may help distinguish mineral from organic material. Iron coatings sometimes show concentric layers in cross section and may transfer iron stains to the fingers when rubbed.

Figure 4-19. Iron oxide plaque (orange coating) on a living root. Iron also coats the channel or pore from which the root was removed.

Indicator C4: Presence of reduced iron

Category: Primary

General Description: Presence of reduced (ferrous) iron in the upper 12 in. (30 cm) of the soil profile, as indicated by a ferrous iron test or by the presence of a soil that changes color upon exposure to the air.

Cautions and User Notes: The reduction of iron occurs in soils that have been saturated long enough to become anoxic and chemically reduced. Ferrous iron is converted to oxidized forms when saturation ends and the soil reverts to an aerobic state. Thus, the presence of ferrous iron indicates that the soil is saturated and anoxic at the time of sampling, and has been saturated for an extended period. The presence of ferrous iron can be verified with alpha, alpha-dipyridyl dye (Figure 4-20, see NRCS Hydric Soils Technical Note 8, http://soils.usda.gov/use/hydric/ntchs/tech_notes/note8.html) or by observing a soil that changes color upon exposure to air (see the section on Problematic Hydric Soils in Chapter 5). A positive reaction to alpha, alpha-dipyridyl dye should occur over more than 50 percent of the soil layer in question. The dye does not react when wetlands are dry; therefore, a negative test result is not evidence that the soil is not reduced at other times of year. Soil samples should be tested or examined immediately after opening the soil pit because ferrous iron may oxidize and colors change soon after the sample is exposed to the air. Soils that contain little weatherable iron may not react even when saturated and reduced.

Figure 4-20. When alpha, alpha-dipyridyl dye is applied to a soil containing reduced iron, a positive reaction is indicated by a pink or red coloration to the treated area.

Indicator C6: Recent iron reduction in tilled soils

Category: Primary

General Description: Presence of 2 percent or more redox concentrations as pore linings in the plowed surface layer of soils cultivated within the last two years.

Cautions and User Notes: Cultivation breaks up or destroys redox features in the plow zone. The presence of intact redox features indicates that the soil was saturated and reduced since the last episode of cultivation (Figure 4-21). Redox features often form around organic material incorporated into the tilled soil. Use caution with relict features that may be broken up but not destroyed by tillage. The indicator is most reliable in areas that are cultivated regularly, so that soil aggregates and older redox features are more likely to be broken up.

Figure 4-21. Redox concentrations in the surface layer of a recently cultivated soil.

Indicator C2: Dry-season water table

Category: Secondary

General Description: Visual observation of the water table between 12 – 24 in. (30 – 60 cm) below the surface during the normal dry season or during a drier-than-normal year.

Cautions and User Notes: Due to normal seasonal fluctuations, water tables in wetlands often drop below 12 in. during the summer dry season. A water table between 12 and 24 in. during the dry season, or during an unusually dry year, indicates a normal wet-season water table within 12 in. of the surface. Sufficient time must be allowed for water to infiltrate into a newly dug hole and to stabilize at the water-table level. The required time will vary depending upon soil texture. In some cases, the water table can be determined by examining the wall of the soil pit and identifying the upper level at which water is seeping into the pit. For an accurate determination of the water-table level, the soil pit, auger hole, or well should not penetrate any restrictive soil layer capable of perching water near the surface. Water tables in wetlands often drop well below 24 in. during dry periods. Therefore, a dry-season water table below 24 in. does not necessarily indicate a lack of wetland hydrology. See Chapter 5 (section on Wetlands that Periodically Lack Indicators of Wetland Hydrology) for determining average dry-season dates and drought periods.

Indicator C9: Saturation visible on aerial imagery

Category: Secondary

General Description: One or more recent aerial photographs or satellite images show soil saturation. Saturated soil signatures must correspond to field-verified hydric soils, depressions or drainage patterns, differential crop management, or other evidence of a seasonal high water table.

Cautions and User Notes: This indicator is useful when plant cover is sparse or absent and the ground surface is visible from above. Saturated areas generally appear as darker patches within the field (Figure 4-22). Inundated (indicator B7) and saturated areas may be present in the same field; if they cannot be distinguished, then use indicator C9 for the entire wet area. Care must be used in applying this indicator because saturation may be present on a non-wetland site immediately after a heavy rain or during periods of abnormally high precipitation, runoff, tides, or river stages. Saturation observed during the non-growing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season for sufficient duration in most years. Saturation may be absent from a wetland during the normal dry season or during extended periods of drought. Even under normal rainfall conditions, some wetlands do not become inundated or saturated every year (i.e., 50 percent or higher probability). If 5 or more years of aerial photography are available, the procedure described by the Natural Resources Conservation Service (1997, section 650.1903) is recommended. Use caution, as similar signatures may be caused by factors other than saturation. This indicator requires onsite verification that saturation signatures seen on photos correspond to hydric soils or other evidence of a seasonal high water table.

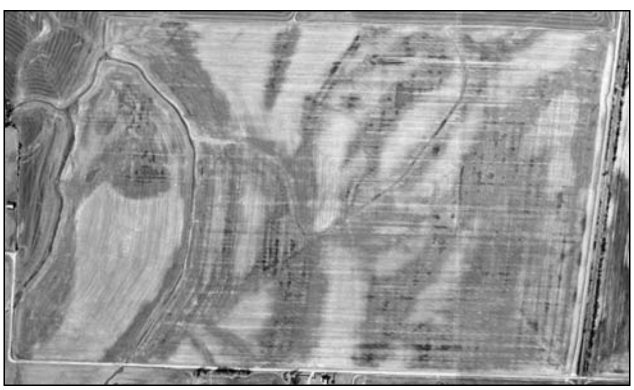

Figure 4-22. Aerial photograph of an agricultural field with saturated soils indicated by darker colors.

Group D – Evidence from Other Site Conditions or Data

Indicator: D1 – Stunted or stressed plants

Category: Primary

General Description: In agricultural or planted vegetation located in a swale or other topographically low area, this indicator is present if individuals of the same species growing in the potential wetland are clearly of smaller stature, less vigorous, or stressed compared with individuals growing in nearby drier landscape situations.

Applicable Subregion: Applicable to the Northwest Forests and Coast Subregion (LRR A).

Cautions and User Notes: Usually this indicator is associated with a swale or similar topographic depression. Agricultural crops and other introduced or planted species, such as alfalfa (*Medicago* spp.), oats (*Avena* spp.), and ryegrass (*Lolium* spp.), can become established in wetlands but often exhibit obvious stunting, yellowing, or stress in wet situations (Figure 4-23). Use caution in areas where stunting of plants on non-wetland sites may be caused by low soil fertility, excessively drained soils, salinity, cold temperatures, uneven application of agricultural chemicals, or other factors. For this indicator to be present, a majority of individuals in the potential wetland area must be stunted or stressed. This indicator is restricted to agricultural or planted vegetation. It is often seen where early-season germination and establishment of cultivated or planted species occurs before the onset of seasonal wetland hydrology. As a result, established plants can exhibit differential growth patterns and stress between areas that have wetland hydrology and areas that are better drained.

Figure 4-23. Stunted corn due to wet spots in an agricultural field.

Indicator D2: Geomorphic position

Category: Secondary

General Description: This indicator is present if the area in question is located in a localized depression, linear swale or drainageway, concave position within a floodplain, at the toe of a slope, on an extensive flat, on the low-elevation fringe of a pond or other water body, or in an area where groundwater discharges.

Cautions and User Notes: Excess water from precipitation and snowmelt naturally accumulates in certain geomorphic positions in the landscape, particularly in low-lying areas such as depressions, drainages, toe slopes, and fringes of water bodies. Extensive flats with poor drainage accumulate snowmelt in mountain areas. In mountain and coastal areas that receive relatively abundant rainfall and snowmelt, these geomorphic settings often, but not always, exhibit wetland hydrology. This indicator does not include concave positions on rapidly permeable soils (e.g., floodplains with sand and gravel substrates) that do not have wetland hydrology unless the water table is near the surface.

Indicator D3: Shallow aquitard

Category: Secondary

General Description: This indicator occurs in and around the margins of depressions, such as temporary pools, and consists of the presence of an aquitard within the soil profile that is potentially capable of perching water within 12 in. (30 cm) of the surface.

Cautions and User Notes: An aquitard is a relatively impermeable soil layer or bedrock that slows the downward infiltration of water and can produce a perched water table, generally in flat or depressional landforms. In some cases, the aquitard may be at the surface and cause water to pond on the surface. Potential aquitards include fragipans, cemented layers, dense glacial till, lacustrine deposits, and clay layers. Redoximorphic features often are evident in the layer(s) above the aquitard.

Indicator D4: Frost-heave hummocks

Category: Secondary

General Description: This indicator consists of hummocky microtopography produced by frost action in wetlands.

Cautions and User Notes: During cold winters at high elevations, freeze/thaw action creates hummocky microtopography in saturated soils in and along the edges of wetlands (Figure 4-24). This indicator does not include gilgai microrelief in clay soils (e.g., Vertisols).

Figure 4-24. Frost-heave hummocks.

Indicator D5: FAC-neutral test

Category: Secondary

General Description: The plant community passes the FAC-neutral test.

Cautions and User Notes: The FAC-neutral test is performed by compiling a list of dominant plant species across all strata in the community, and dropping from the list any species with a Facultative indicator status (i.e., FAC, FAC–, and FAC+). The FAC-neutral test is met if more than 50 percent of the remaining dominant species are rated FACW and/or OBL. This indicator may be used in communities that contain no FAC dominants. If there are an equal number of dominants that are OBL and FACW versus FACU and UPL, nondominant species should be considered. This indicator is only applicable to wetland hydrology determinations.

Indicator D6: Raised ant mounds

Category: Secondary

General Description: Presence of elevated ant mounds 6 in. (15 cm) or more in height built in response to seasonal flooding, ponding, or high water tables.

Applicable Subregions: Applicable to the Northwest Forests and Coast Subregion (LRR A).

Cautions and User Notes: In well-drained soils, ground-nesting ants build mounds that are typically less than 4-5 in. (10-12 cm) in height. However, in areas that are seasonally flooded, ponded, or have a water table near the surface, species such as the silky ant (*Formica fusca*) build exaggerated, cylindrical mounds up to 20 in. (50 cm) tall that serve to elevate the nest above water level (Landa 1977). These nests often have grasses and other plants growing on their tops and sides and may be very numerous, giving the wet area a hummocky appearance (Figure 4-25).

Figure 4-25. Raised ant mounds in a Willamette Valley, OR, wetland.

5 Difficult Wetland Situations in the Western Mountains, Valleys and Coast Region

Introduction

Some wetlands can be difficult to identify because wetland indicators may be missing at times due to natural processes or recent disturbances. This chapter provides guidance for making wetland determinations in difficult-to-identify wetland situations in the Western Mountains, Valleys and Coast Region. It includes regional examples of Problem Area wetlands and Atypical Situations as defined in the Corps Manual, as well as other situations that can make wetland delineation more challenging. Problem Area wetlands are defined as naturally occurring wetland types that periodically lack indicators of hydrophytic vegetation, hydric soil, or wetland hydrology due to normal seasonal or annual variability. In addition, some Problem Area wetlands may permanently lack certain indicators due to the nature of the soils or plant species on the site. Atypical Situations are defined as wetlands in which vegetation, soil, or hydrology indicators are absent due to recent human activities or natural events. This chapter also provides a field procedure for quantifying the extent of wetlands in areas where wetlands and non-wetlands are highly interspersed in a mosaic pattern. The chapter is organized into the following sections:

- Problematic Hydrophytic Vegetation
- Problematic Hydric Soils
- Wetlands that Periodically Lack Indicators of Wetland Hydrology
- Wetland/Non-Wetland Mosaics

The list of difficult wetland situations presented in this chapter is not intended to be exhaustive and other such situations may exist in the region. See the Corps Manual for general guidance. In general, *wetland determinations on difficult or problematic sites must be based on the best information available to the field inspector, interpreted in light of his or her personal experience and knowledge of the ecology of wetlands in the region*.

Problematic Hydrophytic Vegetation

Many factors affect the structure and composition of plant communities in the Western Mountains, Valleys and Coast Region, including climatic variability, ephemeral water sources in some places, superabundance of moisture in others, salinity, and human land-use practices. As a result, some wetlands may exhibit indicators of hydric soil and wetland hydrology but lack any of the hydrophytic vegetation indicators presented in Chapter 2, at least at certain times. To identify and delineate these wetlands may require special procedures or additional analysis of factors affecting the site. To the extent possible, the hydrophytic vegetation decision should be based on the plant community that is normally present during the wet portion of the growing season in a normal rainfall year. The following procedure addresses several examples of problematic vegetation situations in the Western Mountains, Valleys and Coast Region.

Recommended Procedure

Problematic hydrophytic vegetation can be identified and delineated using a combination of observations made in the field and/or supplemental information from the scientific literature and other sources. These procedures should be applied only where indicators of hydric soil and wetland hydrology are present, unless one or both of these factors is also problematic, but no indicators of hydrophytic vegetation are evident. The following procedures are recommended:

1. Verify that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present. If indicators of either hydric soil or wetland hydrology are absent, the area is likely non-wetland unless soil and/or hydrology are also disturbed or problematic. If indicators are present, proceed to step 2 (Specific Problematic Vegetation Situations below) or step 3 (General Approaches to Problematic Hydrophytic Vegetation on page 89) and follow the suggested steps. In the remarks section of the data form or in the delineation report, explain the rationale for concluding that the plant community is hydrophytic even though indicators of hydrophytic vegetation described in Chapter 2 were not observed.

2. **Specific Problematic Vegetation Situations**

    a. *Temporal Shifts in Vegetation.* As described in Chapter 2, the species composition of some wetland plant communities in the Western Mountains, Valleys and Coast Region can change in response to seasonal weather patterns and long-term climatic fluctuations. Wetland types that are influenced by these shifts include, but are not limited to, wet prairies, vernal pools and other seasonal depressional wetlands, coastal interdunal wetlands, seeps, and springs. Lack of hydrophytic vegetation during dry periods should not immediately eliminate a site from further consideration as a wetland. A site qualifies for further consideration if the plant community at the time of sampling does not exhibit hydrophytic vegetation indicators, but indicators of hydric soil and wetland hydrology are present. The following sampling and analytical approaches are recommended in these situations:

        1. Seasonal Shifts in Plant Communities

            i. If possible, return to the site during the normal wet portion of the growing season and re-examine the site for indicators of hydrophytic vegetation.

            ii. Examine the site for identifiable plant remains, either alive or dead, or other evidence that the plant community that was present during the normal wet portion of the growing season was hydrophytic.

            iii. Use off-site data sources to determine whether the plant community that is normally present during the wet portion of the growing season is hydrophytic. Appropriate data sources include early growing season aerial photography, NWI maps, soil survey reports, other remotely sensed data, public interviews, and previous reports about the site.

            iv. If the vegetation on the site is substantially the same as that on a wetland reference site having similar soils and known wetland hydrology, then consider the vegetation to be hydrophytic (see step *3b* in this procedure for more information).

2. Extended Drought Conditions (i.e., lasting more than two growing seasons)

   i. Investigate climate records (e.g., WETS tables, drought indices) to determine if the area is under the influence of a drought (for more information, see the section on "Wetlands that Periodically Lack Indicators of Wetland Hydrology" later in this chapter). If so, evaluate any off-site data that provide information on the plant community that exists on the site during normal years, including aerial photography, NWI maps, other remote sensing data, soil survey reports, public interviews, and previous site reports. Determine whether the vegetation that is present during normal years is hydrophytic.

   ii. If the vegetation on the drought-affected site is substantially the same as that on a wetland reference site in the same general area having similar soils and known wetland hydrology, then consider the vegetation to be hydrophytic (see step *3b* in this procedure).

b. *Sparse and Patchy Vegetation.* Some wetlands in the Western Mountains, Valleys and Coast Region have sparse or patchy vegetation cover. Examples include some tidal marshes, alkaline flats, kettle depressions, and interdunal swale wetlands. These areas may have indicators of hydric soils and wetland hydrology, but the vegetation is not continuous across or along the boundary of the wetland. Delineation of these areas can be confusing due to the interspersion of wetlands and other potential waters of the United States. For wetland delineation purposes, an area should be considered vegetated if there is 5 percent or more areal cover of plants at the peak of the growing season. Unvegetated areas have less than 5 percent plant cover. Patchy vegetation is a mosaic of both vegetated and unvegetated areas (Figure 5-1). In some cases, the unvegetated portions of a wet site may be considered as other waters of the United States. See the Arid West regional supplement (U. S. Army Corps of Engineers 2006) for further information.

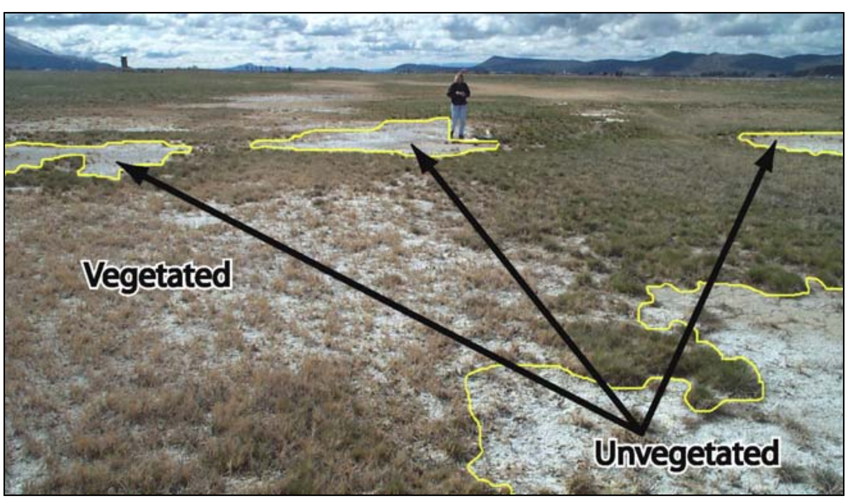

Figure 5-1. Example of sparse and patchy plant cover in a wetland. Areas labeled as vegetated have 5 percent or more plant cover.

c. *Riparian Areas.* Riparian ecosystems are highly variable across the Western Mountains, Valleys and Coast Region. Riparian corridors can be lined with hydrophytic vegetation, upland vegetation, unvegetated areas, or a mosaic of these types. Soils may lack hydric soil indicators in recently deposited materials (i.e., Entisols) even when indicators of hydrophytic vegetation and wetland hydrology are present. Surface hydrology can vary from perennial to intermittent and, after a flooding event, water tables can drop quickly to low levels. Many riparian areas contain remnant stands of tree species that may have germinated during unusually high water events or under wetter conditions than currently exist at the site (Figure 5-2). Examples of species that occur in these situations include narrowleaf cottonwood, willows, balsam poplar, and red alder. These areas may have a high frequency of phreatophytic species that, when mature, are able to exploit groundwater that is too deep to support wetlands. In such situations, there may be a hydrophytic overstory and a non-hydrophytic understory. If the soils are Entisols lacking hydric soil features and/or wetland hydrology is problematic, more emphasis should be placed on the understory, which may be more indicative of current wetland or non-wetland conditions.

Figure 5-2. Mature *Populus deltoides* stand on an elevated floodplain terrace with xeric understory on the South Fork of the Shoshone River, Wyoming.

d. *Areas Affected by Grazing.* Both short- and long-term grazing can cause shifts in dominant species in the vegetation. Grazers can influence the abundance of plant species in several ways. For instance, trampling by large herbivores can cause soil compaction, altering soil permeability and infiltration rates and affecting the plant community. Grazers can also influence the abundance of plant species by selectively grazing certain species or avoiding other species. This shift in species composition due to grazing can influence the hydrophytic vegetation determination. Be aware that shifts in both directions, favoring either wetland species or non-wetland species, can occur in these situations. Limited grazing does not necessarily affect the outcome of a hydrophytic vegetation decision. However, the following procedure is recommended in cases where the hydrophytic vegetation determination would be unreliable or misleading due to the effects of grazing.

1. Examine the vegetation on a nearby, ungrazed reference site having similar soils and hydrologic conditions. Ungrazed areas may be present on adjacent properties or in fenced exclosures or streamside management zones. Assume that the same plant community would exist on the grazed site, in the absence of grazing.

2. If feasible, remove livestock or fence representative livestock exclusion areas to allow the vegetation time to recover from grazing, and reevaluate the vegetation during the next growing season.

3. If grazing was initiated recently, use offsite data sources such as aerial photography, NWI maps, and interviews with persons familiar with the site or area to determine what plant community was present on the site before grazing began. If the previously ungrazed community was hydrophytic, then consider the current vegetation to be hydrophytic.

4. If an appropriate ungrazed area cannot be located or if the ungrazed vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soils and wetland hydrology.

e. *Managed Plant Communities.* Many natural plant communities throughout the region have been altered and are managed to meet human goals. Examples include clearing of woody vegetation on rangelands, periodic disking or plowing, planting of native and non-native species, irrigation of pastures and hayfields, suppression of wildfires, and the use of herbicides. These actions can result in elimination of certain species and their replacement with other species, changes in abundance of certain plants, and shifts in dominant species, possibly influencing a hydrophytic vegetation determination. The following procedure is recommended if the natural vegetation has been altered through management to such an extent that a hydrophytic vegetation determination may be unreliable:

1. Examine the vegetation on a nearby, unmanaged reference site having similar soils and hydrologic conditions. Assume that the same plant community would exist on the managed site, in the absence of human alteration.

2. For recently cleared or plowed areas (not planted or seeded), leave representative areas unmanaged for at least one growing season with normal rainfall and reevaluate the vegetation.

3. If management was initiated recently, use offsite data sources such as aerial photography, NWI maps, and interviews with knowledgeable persons to determine what plant community was present on the site before the management occurred.

4. If the unmanaged vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

f. *Aggressive Invasives.* Native and non-native aggressive, invasive FACU or UPL plant species often become established in wetlands due to their adaptability and aggressive growth habits. Invasives include planted or seeded species that have escaped and become widely established. Often, these invasive species preclude establishment of other species by competing successfully for space, sunlight, or other resources. Examples include blackberry (*Rubus discolor* and *R. ursinus*), English ivy (*Hedera helix*), gorse (*Ulex europaeus*), and various pasture species, such as creeping soft grass (*Holcus mollis*) and sweet vernal grass (*Anthoxanthum odoratum*). The following procedure is recommended when the plant community has hydric soil and wetland hydrology indicators and is dominated by FACU or UPL aggressive, invasive plant species:

1. Examine a nearby reference site having similar soils, topography, and hydrologic conditions, and a similar plant community without or with reduced presence of the invasive species. Assume that the same plant community would exist on the original site, if invasive species were not prevalent.

2. If feasible, remove the invasive species and reevaluate the vegetation during the next growing season. Take into consideration that many invasive species are very difficult to remove and will re-sprout or re-emerge next season. However, even temporary removal of the invasive may release other species.

3. If an appropriate reference site cannot be located and the invasive species cannot be removed and the site reevaluated next season, make the wetland determination based on indicators of hydric soil and wetland hydrology.

g. *Areas Affected by Fires, Floods, and Other Natural Disturbances.* Wildfires, floods, and other catastrophic disturbances can dramatically alter the vegetation on a site. Vegetation can be completely or partially removed, or its composition altered, depending upon the intensity of the disturbance. Limited disturbance does not necessarily affect the investigator's ability to determine whether the plant community is or is not hydrophytic. However, if the vegetation on a site has been removed or made unidentifiable by a recent fire, flood, or other disturbance, then one or more of the following procedures may be used to determine whether the vegetation present before the disturbance was hydrophytic. Additional guidance can be found in Part IV, Section F (Atypical Situations) of the Corps Manual.

1. Examine the vegetation on a nearby, undisturbed reference site having similar soils and hydrologic conditions. Assume that the same plant community would exist on the disturbed site in the absence of disturbance.

2. Use off-site information sources such as aerial photography, NWI maps, and interviews with knowledgeable individuals to determine the plant community present on the site before the disturbance.

3. If the undisturbed vegetation condition cannot be determined, make the wetland determination based on indicators of hydric soil and wetland hydrology.

h. *Vigor and stress responses to wetland conditions.* Plant responses to wet site conditions are often easily observable. Many plants develop stress-related features, such as stunting in agricultural crops and browning or yellowing of native or planted vegetation, when subjected to long periods of soil saturation in the root zone. Crop stress in wet agricultural fields is often easily identifiable both in the field and on aerial photography. In relatively frost-free areas, such as near the Pacific coast, early-season germination of FACU and UPL species occurs in some wetlands (e.g., vernal pools) prior to the onset of seasonal hydrology. These plants may persist and dominate in wetlands during the normal wet season, but often show evidence of stress (e.g., stunting, browning, yellowing) compared to the same species growing in nearby non-wetlands. In addition, many species grow more abundantly or vigorously on wet sites, particularly later in the growing season when adjacent areas are drying out but moist soils are still present in wetlands. These responses are not species specific or easily measurable but are evident when the vegetation of wetlands and adjacent non-wetlands is compared. The following procedure can help determine whether an observed increase or decrease in plant vigor or stress is the result of growing in wetlands. The procedure assumes that indicators of hydric soil and wetland hydrology are present in the potential wetland area. Use caution in areas where variations in plant vigor or stress may be due to variations in salinity or other soil conditions, uneven application of fertilizers or herbicides, or other factors not related to wetness.

1. Compare and describe in field notes the size, vigor, or other stress-related characteristics of individuals of the same species between the potential wetland area and the immediately surrounding non-wetlands. Emphasize features that can be measured or photographed and include this information in the field report. To qualify for this procedure, most individuals of the affected species must show vigor/stress responses in the wet area. If there are clear differences in plant vigor/stress responses between potential wetland and adjacent non-wetland areas, proceed to step 2.

2. Observe and describe trends in plant vigor or stress conditions along the topographic or wetness gradient from the potential wetland to the adjacent non-wetland areas. Trends in plant vigor/stress responses must reflect the distribution of hydric soils, wetland hydrology indicators, topography, and/or landscape conditions relevant to wetlands. If so, proceed to step 3.

3. Consider the area containing indicators of hydric soil, wetland hydrology, and evidence of plant vigor or stress to be a wetland. Determine the wetland boundary based on the spatial patterns in these features plus topography and landscape characteristics.

3. **General Approaches to Problematic Hydrophytic Vegetation** – The following general procedures are provided to identify hydrophytic vegetation in difficult situations not necessarily associated with specific vegetation types or management practices, including wetlands dominated by FACU species that are functioning as hydrophytes. These procedures should be applied only where indicators of hydric soil and wetland hydrology are present but indicators of hydrophytic vegetation are not evident. The following approaches are recommended:

   a. *Direct hydrologic observations.* Verify that the plant community occurs in an area subject to prolonged inundation or soil saturation during the growing season. For example, lodge-pole pine (*Pinus contorta*), a FAC to FACU species in the region, occasionally dominates the vegetation in areas that have saturated soil conditions during the early part of the growing season. Other examples of FACU species that sometimes dominate wetlands in the region include western hemlock (Kuchler 1946, Waring and Franklin 1979), ponderosa pine, salal (*Gaultheria shallon*), Himalayan blackberry (*Rubus armeniacus = R. discolor = R. procerus*), and Kentucky bluegrass (*Poa pratensis*) (indicator status may vary by plant list region). These areas can be evaluated by visiting the site at 2- to 3-day intervals during the portion of the growing season when surface water is most likely to be present or water tables are normally high. Hydrophytic vegetation is considered to be present, and the site is a wetland, if surface water is present and/or the water table is 12 in. (30 cm) or less from the surface for 14 or more consecutive days during the growing season in a normal or drier-than-normal year. If necessary, microtopographic highs and lows should be evaluated separately. The normality of the current year's rainfall must be considered in interpreting field results, as well as the likelihood that wet conditions will occur on the site at least every other year (for more information, see the section on "Wetlands that Periodically Lack Indicators of Wetland Hydrology" in this chapter).

b. *Reference sites.* If indicators of hydric soil and wetland hydrology are present, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are substantially the same as those on nearby wetland reference areas. Wetland reference areas should have documented hydrology established through long-term monitoring or by repeated application of the procedure described in item *3a* above. Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the district or field office.

c. *Technical literature.* Published and unpublished scientific literature may be used to support a decision to treat specific FACU species as hydrophytes or certain plant communities as hydrophytic. Preferably, this literature should discuss the species' natural distribution along the moisture gradient, its capabilities and adaptations for life in wetlands, wetland types in which it is typically found, or other wetland species with which it is commonly associated.

Problematic Hydric Soils

Soils with Faint or No Indicators

Some soils that meet the hydric soil definition may not exhibit any of the indicators presented in Chapter 3. These problematic hydric soils exist for a number of reasons and their proper identification requires additional information, such as landscape position, presence or absence of restrictive soil layers, or information about hydrology. This section describes several soil situations in the Western Mountains, Valleys and Coast Region that are considered hydric if additional requirements are met. In some cases, these hydric soils may appear non-hydric due to the color of the parent material from which the soils developed. In others, the lack of hydric soil indicators is due to conditions that inhibit the development of redoximorphic features despite prolonged soil saturation and anoxia. In addition, recently developed wetlands may lack hydric soil indicators because insufficient time has passed for their development. Examples of problematic hydric soils in the region include, but are not limited to, the following.

1. **Moderately to Very Strongly Alkaline Soils.** This problematic situation is limited to the Rocky Mountain Forests and Rangeland Subregion (LRR E) and is associated with depressional wetlands at lower elevations. The formation of redox concentrations and depletions requires that soluble iron and organic matter be present in the soil. In a neutral to acidic soil, iron readily enters into solution as reduction occurs and then precipitates in the form of redox concentrations as the soil becomes oxidized. Identifiable iron or manganese features do not form readily in saturated soils with high pH. High pH (7.9 or higher) can be caused by many factors. In the Western Mountains, Valleys and Coast Region, salt content is a common cause of high soil pH. If the pH is high, indicators of hydrophytic vegetation and wetland hydrology are present, and landscape position is consistent with wetlands in the area, then the soil may be hydric even in the absence of a recognized hydric soil indicator. In the absence of an approved indicator, thoroughly document soil conditions, including pH, in addition to the rationale for identifying the soil as hydric (e.g., landscape position, vegetation, evidence of hydrology, etc.). The concept of high pH includes the USDA terms Moderately Alkaline, Strongly Alkaline, and Very Strongly Alkaline (USDA Natural Resources Conservation Service 2002).

2. **Volcanic Ash or Diatomaceous Earth.** Many of these soils have high levels of silica that naturally have high value and low chroma. These soils also are inherently low in iron, manganese, and sulfur. Many hydric soil indicators are formed predominantly by the accumulation or loss of iron, manganese, or sulfur and, therefore, cannot form in these soils. In the absence of an approved indicator, soil and landscape conditions should be documented thoroughly, along with the rationale for considering the soil to be hydric (e.g., landscape position, vegetation, evidence of hydrology, etc.). A soil scientist with local experience may be needed to help determine whether soils were developed from volcanic ash or diatomaceous earth.

3. **Vegetated Sand and Gravel Bars within Floodplains.** Coarse-textured soils commonly occur on vegetated bars above the active channel of rivers and streams. In some cases, these soils lack hydric soil indicators due to seasonal or annual deposition of new soil material, low iron or manganese content, and low organic-matter content. Redox concentrations can sometimes be found on the bottoms of coarse fragments and should be examined closely to see if they satisfy an indicator.

4. **Dark Parent Materials.** Soils formed in dark parent materials often do not exhibit easily recognizable redoximorphic features. These soils are not dark due to high organic-matter content but, rather, because they formed from parent materials such as dark shales and phyllites. In the absence of an approved indicator, soil and landscape conditions should be documented thoroughly. Describe soil characteristics of surrounding uplands that are the likely source of dark parent materials, and include the rationale for considering the soil in question to be hydric (e.g., landscape position, vegetation, evidence of hydrology, etc.).

5. **Recently Developed Wetlands.** Recently developed wetlands include mitigation sites, wetland management areas (e.g., for waterfowl), other wetlands intentionally or unintentionally produced by human activities, and naturally occurring wetlands that have not been in place long enough to develop hydric soil indicators.

6. **Seasonally Ponded Soils.** Seasonally ponded, depressional wetlands occur in basins and valleys throughout the Western Mountains, Valleys and Coast Region. Most are perched systems, with water ponding above a restrictive soil layer, such as a hardpan or clay layer

that is at or near the surface (e.g., Vertisols). Some of these wetlands lack hydric soil indicators due to limited saturation depth, saline conditions, or other factors.

Soils with Relict Hydric Soil Indicators

Some soils in the Western Mountains, Valleys and Coast Region exhibit redoximorphic features and hydric soil indicators that formed in the recent or distant past when conditions may have been wetter than they are today. These features have persisted even though wetland hydrology may no longer be present. Examples include abandoned river courses and areas adjacent to deeply incised stream channels. In addition, wetlands that were drained for agricultural purposes starting in the 1800s may contain persistent hydric soil features. Wetland soils drained during historic times are still considered hydric but they may no longer support wetlands. Relict and historic hydric soil features may be difficult to distinguish from contemporary features. However, if indicators of hydrophytic vegetation and wetland hydrology are present, then hydric soil indicators can be assumed to be contemporary.

Procedure

Soils that meet the definition of a hydric soil but do not exhibit any of the indicators described in Chapter 3 can be identified by the following recommended procedure. This procedure should be used only where indicators of hydrophytic vegetation and wetland hydrology are present but indicators of hydric soil are not evident. Use caution in areas where vegetation and hydrology are also problematic.

1. Verify that one or more indicators of hydrophytic vegetation are present. If so, proceed to step 2.

2. Verify that at least one primary or two secondary indicators of wetland hydrology are present. If so, proceed to step 3. If indicators of hydrophytic vegetation and/or wetland hydrology are absent, then the area is probably non-wetland and no further analysis is required.

3. Thoroughly describe and document the soil profile and landscape setting. Verify that the area is in a landscape position that is likely to collect or concentrate water. Appropriate settings are listed below. If the landscape setting is appropriate, proceed to step 4.

    a. Concave surface (e.g., depression or swale)
    b. Active floodplain or low terrace
    c. Level or nearly level area (e.g., 0 to 3 percent slope)
    d. Toe slope or an area of convergent slopes
    e. Fringe of another wetland or water body
    f. Area with a restrictive soil layer or aquitard within 24 in. (60 cm) of the surface
    g. Other (explain in field notes why this area is likely to be inundated or saturated for long periods)

4. Use one or more of the following approaches to determine whether the soil is hydric. In the remarks section of the data form or in the delineation report, explain why it is believed that the soil lacks any of the NTCHS hydric soil indicators described in Chapter 3 and why it is believed that the soil meets the definition of a hydric soil.

a. Determine whether one or more of the following indicators of problematic hydric soils is present. Descriptions of each indicator are given in Chapter 3. If one or more indicators is present, then the soil is hydric.

   i. 2 cm Muck (A10)
   ii. Red Parent Material (TF2)

b. Determine whether one or more of the following problematic soil situations is present. If present, consider the soil to be hydric.

   i. Moderately to Very Strongly Alkaline Soils (LRR E)
   ii. Volcanic Ash or Diatomaceous Earth
   iii. Vegetated Sand and Gravel Bars within Floodplains
   iv. Dark Parent Materials
   v. Recently Developed Wetlands
   vi. Seasonally Ponded Soils
   vii. Other (in field notes, describe the problematic soil situation and explain why it is believed that the soil meets the hydric soil definition)

c. Soils that have been saturated for long periods and have become chemically reduced may change color when exposed to air due to the rapid oxidation of ferrous iron (Fe^{+2}) to Fe^{+3} (Figures 5-3 and 5-4). If the soil contains sufficient iron, this can result in an observable color change, especially in hue or chroma. The soil is hydric if a mineral layer 4 in. (10 cm) or more thick starting within 12 in. (30 cm) of the soil surface that has a matrix value of 4 or more and chroma of 2 or less becomes redder by one or more pages in hue and/or increases one or more in chroma when exposed to air within 30 minutes (Vepraskas 1992).

   Care must be taken to obtain an accurate color of the soil sample immediately upon excavation. The colors should be observed closely and examined again after several minutes. Do not allow the sample to become dry. Dry soils will usually have a different color than wet or moist soils. As always, do not obtain colors while wearing sunglasses. Colors must be obtained in the field under natural light and not under artificial light.

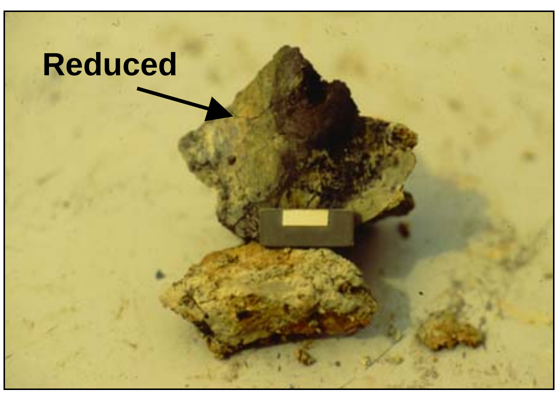

Figure 5-3. This soil exhibits colors associated with reducing conditions. Scale is 1 cm.

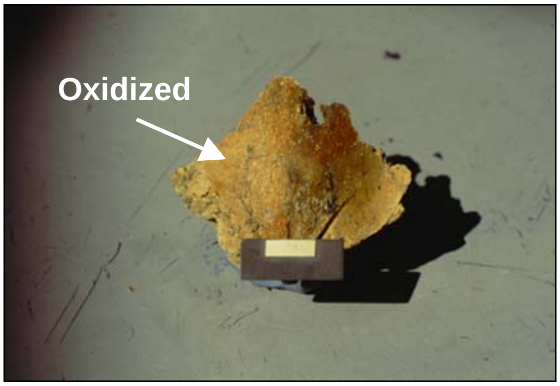

Figure 5-4. The same soil as in Figure 5-3 after exposure to the air and oxidation has occurred.

d. If the soil is saturated at the time of sampling, alpha, alpha-dipyridyl dye can be used in the following procedure to determine if reduced (ferrous) iron is present. If ferrous iron is present as described below, then the soil is hydric.

   Alpha, alpha-dipyridyl is a dye that reacts with reduced iron. In some cases, it can be used to provide evidence that a soil is hydric when it lacks other hydric soil indicators. The soil is likely to be hydric if application of alpha, alpha-dipyridyl dye to mineral soil material in at least 60 percent of a layer at least 4 in. (10 cm) thick within a depth of 12 in. (30 cm) of the soil surface results in a positive reaction within 30 seconds evidenced by a pink or red coloration to the dye during the growing season.

   Using a dropper, apply a small amount of dye to a freshly broken ped face to avoid any chance of a false positive test due to iron contamination from digging tools. Look closely at the treated soil for evidence of color change. If in doubt, apply the dye to a sample of known upland soil and compare the reaction to the sample of interest. A positive reaction will not occur in soils that lack iron. This lack of a positive reaction to the dye does not preclude the presence of a hydric soil. Specific information about the use of alpha, alpha-dipyridyl can be found in NRCS Hydric Soils Technical Note 8 (http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html).

e. Using gauge data, water-table monitoring data, or repeated direct hydrologic observations, determine whether the soil is ponded or flooded, or the water table is 12 in. (30 cm) or less from the surface, for 14 or more consecutive days during the growing season in most years (50 percent or higher probability) (U. S. Army Corps of Engineers 2005). If so, then the soil is hydric. Furthermore, any soil that meets the NTCHS hydric soil technical standard (NRCS Hydric Soils Technical Note 11, http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html) is hydric.

Wetlands that Periodically Lack Indicators of Wetland Hydrology

Description of the Problem

Wetlands are areas that are flooded or ponded, or have soils that are saturated with water, for long periods during the growing season in most years. If the site is visited during a time of normal precipitation amounts and it is inundated or the water table is near the surface, then the wetland hydrology determination is straightforward. However, much of the Western Mountains, Valleys and Coast Region is characterized by long, hot summer dry seasons. During the dry season, surface water recedes from wetland margins, water tables drop, and many wetlands dry out completely. Superimposed on this seasonal cycle is a long-term pattern of multi-year droughts alternating with years of higher-than-average rainfall. Wetlands in general are inundated or saturated in most years (50 percent or higher probability) over a long-term record. However, some wetlands in the Western Mountains, Valleys and Coast Region do not become inundated or saturated in some years and, during drought cycles, may not inundate or saturate for several years in a row.

Wetland hydrology determinations are based on indicators, many of which were designed to be used during dry periods when the direct observation of surface water or a shallow water table is not possible. However, some wetlands may lack any of the listed hydrology indicators, particularly during the dry season or in a dry year. The evaluation of wetland hydrology requires special care on any site where indicators of hydrophytic vegetation and hydric soil are present but hydrology indicators appear to be absent. Among other factors, this evaluation should consider the timing of the site visit in relation to normal seasonal and annual hydrologic variability, and whether the amount of rainfall prior to the site visit has been normal. This section describes a number of approaches that can be used to determine whether wetland hydrology is present on sites where indicators of hydrophytic vegetation and hydric soil are present but hydrology indicators may be lacking due to normal variations in rainfall or runoff, human activities that destroy hydrology indicators, and other factors.

Procedure

1. Verify that indicators of hydrophytic vegetation and hydric soil are present. Use caution in areas where soils and/or vegetation may also be problematic. Proceed to step 2.

2. Verify that the site is in a geomorphic position where wetlands are likely to occur (e.g., in a depression or swale, level or nearly level area, toe slope, area of convergent slopes, low terrace, active floodplain or backwater, the fringe of another wetland or water body, or on a soil with a shallow restrictive layer). If so, proceed to step 3.

3. Use one or more of the following approaches to determine whether wetland hydrology is present and the site is a wetland. In the remarks section of the data form or in the delineation report, explain the rationale for concluding that wetland hydrology is present even though indicators of wetland hydrology described in Chapter 4 were not observed.

    a. *Site visits during the dry season*. Determine whether the site visit occurred during the normal annual “dry season.” The dry season, as used in this supplement, is the period of the year when soil moisture is normally being depleted and water tables are falling to low levels in response to decreased precipitation and/or increased evapotranspiration, usually during late spring and summer. It also includes the beginning of the recovery period in late summer or fall. The Web-Based Water-Budget Interactive Modeling Program (WebWIMP) is one source for approximate dates of wet and dry seasons for any terrestrial location based on average monthly precipitation and estimated evapotranspiration (http://climate.geog.udel.edu/~wimp/). In general, the dry season in a typical year is indicated when potential evapotranspiration exceeds precipitation (indicated by negative values of DIFF in the WebWIMP output), resulting in drawdown of soil moisture storage (negative values of DST) and/or a moisture deficit (positive values of DEF, also called the unmet atmospheric demand for moisture). Actual dates for the dry season may vary by locale and year.

In many wetlands, direct observation of flooding, ponding, or a shallow water table would be unexpected during the dry season. Wetland hydrology indicators, if present, would most likely be limited to indirect evidence, such as water marks, drift deposits, or surface cracks. In some situations, hydrology indicators may be absent during the dry season. If the site visit occurred during the dry season on a site that contains hydric soils and hydrophytic vegetation and no evidence of hydrologic manipulation (e.g., no drainage ditches, dams, levees, water diversions, etc.), then consider the site to be a wetland. If necessary, re-visit the site during the normal wet season and check again for the presence or absence of wetland hydrology indicators. If wetland hydrology indicators are absent during the wet portion of the growing season in a normal or wetter-than-normal rainfall year, the site is probably non-wetland.

b. *Periods with below normal rainfall*. Determine whether the amount of rainfall that occurred in the 2-3 months preceding the site visit was normal, above normal, or below normal based on the normal range reported in WETS tables. WETS tables are provided by the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html) and are calculated from long-term (30-year) weather records gathered at National Weather Service meteorological stations. To determine whether precipitation was normal prior to the site visit, actual rainfall in the current month and previous 2-3 months should be compared with the normal ranges for each month given in the WETS table (USDA Natural Resources Conservation Service 1997, Sprecher and Warne 2000). The lower and upper limits of the normal range are indicated by the columns labeled "30% chance will have less than" and "30% chance will have more than" in the WETS table. The USDA Natural Resources Conservation Service (1997, Section 650.1903) also gives a procedure that can be used to weight the information from each month and determine whether the entire period was normal, wet, or dry. In mountainous areas, average precipitation amounts can vary considerably over short distances. Therefore, use caution in areas where elevation, aspect, rain shadow effects, or other conditions differ between the site and the location of the nearest weather station. Sometimes a more distant station is more representative of the site in question.

When precipitation has been below normal, wetlands may not flood, pond, or develop shallow water tables even during the typical wet portion of the growing season and may not exhibit other indicators of wetland hydrology. Therefore, if precipitation was below normal prior to the site visit, and the site contains hydric soils and hydrophytic vegetation and no evidence of hydrologic manipulation (e.g., no drainage ditches, dams, levees, water diversions, etc.), it should be identified as a wetland. If necessary, the site can be re-visited during a period of normal rainfall and checked again for hydrology indicators.

c. *Drought years*. Determine whether the area has been subject to short- or long-term drought. Droughts lasting two to several years in a row are common in the region, particularly in interior portions away from the Pacific coast. Drought periods can be identified by comparing annual rainfall totals with the normal range of annual rainfall given in WETS tables or by examining trends in drought indices, such as the Palmer Drought Severity Index (PDSI) (Sprecher and Warne 2000). PDSI takes into account not only precipitation but also temperature, which affects evapotranspiration, and soil moisture conditions. The index is usually calculated on a monthly basis for major climatic divisions within each state. Therefore, the information is not site-specific. PDSI ranges generally between –6 and +6 with negative values indicating dry periods and positive values indicating wet periods. An index of –1.0 indicates mild drought, –2.0 indicates moderate drought, –3.0 indicates severe drought, and –4.0 indicates extreme drought. Time-series plots of PDSI values by month or year are available from the National Climatic Data Center at (http://www.ncdc.noaa.gov/oa/climate/onlineprod/drought/xmgr.html#ds). If wetland hydrology indicators appear to be absent on a site that has hydrophytic vegetation and hydric soils, no evidence of hydrologic manipulation (e.g., no drainage ditches, dams, levees, water diversions, etc.), and the region has been affected by drought, then the area should be identified as a wetland.

d. *Years with unusually low winter snowpack*. Determine whether the site visit occurred following a winter with unusually low snowpack. Some wetlands in mountain areas depend upon the melting winter snowpack as a major water source. In areas where the snowpack persists throughout the winter, water availability in spring and early summer depends in part on winter water storage in the form of snow and ice. Therefore, springtime water availability in a given year can be evaluated by comparing the liquid equivalent of snowfall over the previous winter (e.g., October through April) against 30-year averages calculated for NRCS Snowpack Telemetry (SNOTEL) sites (http://www.wcc.nrcs.usda.gov/factpub/ads/) or for National Weather Service meteorological stations (may require a fee, http://lwf.ncdc.noaa.gov/oa/ncdc.html). This procedure may not be reliable in areas where the snowpack is not persistent and water is released intermittently throughout the winter.

In years when winter snowpack is appreciably less than the long-term average, wetlands that depend on snowmelt as an important water source may not flood, pond, or develop shallow water tables and may not exhibit other wetland hydrology indicators. Under these conditions, a site that contains hydric soils and hydrophytic vegetation and no evidence of hydrologic manipulation should be considered to be a wetland. If necessary, the site can be re-visited following a winter with normal snowpack conditions and checked again for wetland hydrology indicators.

e. *Reference sites*. If indicators of hydric soil and hydrophytic vegetation are present on a site that lacks wetland hydrology indicators, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are substantially the same as those on nearby wetland reference areas. Hydrology of wetland reference areas should be documented through long-term monitoring (see item *h* below) or by repeated application of the procedure described in item *3a* on page 89 (Direct Hydrologic Observations) of the procedure for Problematic Hydrophytic Vegetation in this chapter. Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the District or field office.

f. *Hydrology tools*. The "Hydrology Tools" (USDA Natural Resources Conservation Service 1997) is a collection of methods that can be used to determine whether wetland hydrology is present on a potential wetland site that lacks indicators due to disturbance or other reasons, particularly on lands used for agriculture. Generally they require additional information, such as aerial photographs or stream-gauge data, or involve hydrologic modeling and approximation techniques. They should be used only when an indicator-based wetland hydrology determination is not possible or would give misleading results. A hydrologist may be needed to help select and carry out the proper analysis. The seven tools are used to:

1. Analyze stream and lake gauge data
2. Estimate runoff volumes to determine duration and frequency of ponding in depressional areas
3. Evaluate the frequency of wetness signatures on aerial photography (see item *g* below for additional information)
4. Model water-table fluctuations in fields with parallel drainage systems using the DRAINMOD model
5. Estimate the "scope and effect" of ditches or subsurface drain lines
6. Use NRCS state drainage guides to estimate the effectiveness of agricultural drainage systems
7. Analyze data from groundwater monitoring wells (see item *h* below for additional information)

g. *Evaluating multiple years of aerial photography*. Each year, the Farm Service Agency (FSA) takes low-level aerial photographs in agricultural areas to monitor the acreages planted in various crops for USDA programs. NRCS has developed an off-site procedure that uses these photos, or aerial photography from other sources, to make wetland hydrology determinations (USDA Natural Resources Conservation Service 1997). The method is particularly helpful on agricultural lands where human activity has altered or destroyed other wetland indicators.

The procedure uses five or more years of growing-season photography and evaluates each photo for wetness signatures that are described in "wetland mapping conventions" developed by NRCS state offices. Wetness signatures for a particular state or region may include standing water, saturated soils, flooded or drowned-out crops, stressed crops due to wetness, differences in vegetation patterns due to different planting dates, unharvested crops, isolated areas not farmed with the rest of the field, patches of greener vegetation during dry periods, and other evidence of wet conditions. For each photo, the procedure described in item *b* above is used to determine whether the amount of rainfall in the 2-3 months prior to the date of the photo was normal, below normal, or above normal. Only photos taken in normal rainfall years, or an equal number of wetter-than-normal and drier-than-normal years, are used in the analysis. If wetness signatures are observed on photos in more than half of the years included in the analysis, then wetland hydrology is present. Data forms for documenting the wetland hydrology determination are given in section 650.1903 of USDA Natural Resources Conservation Service (1997).

h. *Long-term hydrologic monitoring.* On sites where the hydrology has been manipulated by man (e.g., with ditches, dams, levees, water diversions, land grading) or where natural events (e.g., downcutting of streams, volcanic activity) have altered conditions such that hydrology indicators may be missing or misleading, direct monitoring of surface and groundwater may be needed to verify the presence or absence of wetland hydrology. The U. S. Army Corps of Engineers (2005) provides minimum standards for the design, construction, and installation of water-table monitoring wells, and for the collection and interpretation of groundwater monitoring data, in cases where direct hydrologic measurements are needed to determine whether wetlands are present on highly disturbed or problematic sites. This standard calls for 14 or more consecutive days of flooding, ponding, or a water table 12 in. (30 cm) or less below the soil surface during the growing season at a minimum frequency of 5 years in 10 (50 percent or higher probability), unless a different standard has been established for a particular geographic area or wetland type. A disturbed or problematic site that meets this standard has wetland hydrology. This standard is not intended (1) to overrule an indicator-based wetland determination on a site that is not disturbed or problematic, or (2) to test or validate existing or proposed wetland indicators.

Wetland / Non-Wetland Mosaics

Description of the Problem

In this supplement, “mosaic” refers to a landscape where wetland and non-wetland components are too closely associated to be easily delineated or mapped separately. These areas often have complex microtopography, with repeated small changes in elevation occurring over short distances. The horizontal distance from trough to ridge may be 1 ft (30 cm) or less in some areas, to 10 ft (3 m) or more in broadly hummocky areas. Ridges and hummocks supporting non-hydrophytic species are often interspersed throughout a wetland matrix having clearly hydrophytic vegetation, hydric soils, and wetland hydrology.

Care must be taken to differentiate wetland/non-wetland mosaics from natural wetland types that at first may appear to be a mosaic. For example, coastal Sitka spruce wetlands often support a significant component of non-hydrophytic vegetation that is rooted on top of large tree roots or downed logs rather than in the soil substrate. Plants not rooted in the soil should not be considered in hydrophytic vegetation decisions. Also, anthropogenic factors, such as grazing, may create small ridges that support non-hydrophytic vegetation.

Wetland components of a mosaic are often not difficult to identify. The problem for the wetland delineator is that microtopographic features are too small and intermingled, and there are too many such features per acre, to delineate and map them accurately. Instead, the following sampling approach is designed to estimate the percentage of wetland in the mosaic. From this, the number of acres of wetland on the site can be calculated, if needed.

Procedure

This section identifies two recommended procedures. Other appropriate sampling methods may also be used. Document the method and the rationale for selecting it.

The first step is to identify and flag all contiguous areas of either wetland or non-wetland on the site that are large enough to be delineated and mapped separately. The remaining area should be mapped as "wetland/non-wetland mosaic" and the approximate percentage of wetland within the area determined by the following procedure.

1. Establish one or more continuous line transects across the mosaic area, as needed. Measure the total length of each transect. A convenient method is to stretch a measuring tape along the transect and leave it in place while sampling. If the site is shaped appropriately and multiple transects are used, they should be arranged in parallel with each transect starting from a random point along one edge of the site. However, other arrangements of transects may be needed for oddly shaped sites.

2. Use separate data forms for the swale or trough and for the ridges or hummocks. Sampling of vegetation, soil, and hydrology should follow the general procedures described in the Corps Manual and this supplement. Plot sizes and shapes for vegetation sampling must be adjusted to fit the microtopographic features on the site. Plots intended to sample the troughs should not overlap adjacent hummocks, and vice versa. Only one or two data forms are required for each microtopographic position, and do not need to be repeated for similar features or plant communities. If there are different wetland or non-wetland plant communities, however, each must be represented by one or more plots and data forms.

3. Identify every wetland boundary in every trough or swale encountered along each transect. Each boundary location may be marked with a pin flag or simply recorded as a distance along the stretched tape.

4. Determine the total distance along each transect that is occupied by wetland and non-wetland until the entire length of the line has been accounted for. Sum these distances across transects, if needed. Determine the percentage of wetland in the wetland/non-wetland mosaic by the following formula.

$$\%\ wetland = \frac{Total\ wetland\ distance\ along\ all\ transects}{Total\ length\ of\ all\ transects} \times 100$$

An alternative approach involves point-intercept sampling at fixed intervals along transects across the area designated as wetland/non-wetland mosaic. This method avoids the need to identify wetland boundaries in each swale, and can be carried out by pacing rather than stretching a measuring tape across the site. The investigator uses a compass or other means to follow the selected transect line. At a fixed number of paces (e.g., every two steps) the wetland status of that point is determined by observing indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. Again, a completed data form is not required at every point but at least one representative swale and hummock should be documented with completed forms. After all transects have been sampled, the result is a number of wetland sampling points and a number of non-wetland points. Estimate the percentage of wetland in the wetland/non-wetland mosaic by the following formula:

$$\%\ wetland = \frac{Number\ of\ wetland\ points\ along\ all\ transects}{Total\ number\ of\ points\ sampled\ along\ all\ transects} \times 100$$

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Appendix A
Glossary

This glossary is intended to supplement those given in the Corps Manual and other available sources. See the following publications for terms not listed here:

- Corps Manual (Environmental Laboratory 1987) (http://el.erdc.usace.army.mil/wetlands/pdfs/wlman87.pdf).
- Field Indicators of Hydric Soils in the United States (USDA Natural Resources Conservation Service 2006b) (http://soils.usda.gov/use/hydric/).
- National Soil Survey Handbook, Part 629 (USDA Natural Resources Conservation Service 2005) (http://soils.usda.gov/technical/handbook/contents/part629glossary1.html).

Absolute cover. In vegetation sampling, the percentage of the ground surface that is covered by the aerial portions (leaves and stems) of a plant species when viewed from above. Due to overlapping plant canopies, the sum of absolute cover values for all species in a community or stratum may exceed 100 percent.

Contrast. The color difference between a redox concentration and the dominant matrix color. Differences are classified as faint, distinct, or prominent and are defined in the glossary of USDA Natural Resources Conservation Service (2006b) and illustrated in Table A1.

Depleted matrix. The volume of a soil horizon or subhorizon from which iron has been removed or transformed by processes of reduction and translocation to create colors of low chroma and high value. A, E, and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix. However, they are excluded from the concept of depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present. In some places the depleted matrix may change color upon exposure to air (reduced matrix); this phenomenon is included in the concept of depleted matrix. The following combinations of value and chroma identify a depleted matrix:

- Matrix value of 5 or more and chroma of 1, with or without redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 6 or more and chroma of 2 or 1, with or without redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 4 or 5 and chroma of 2, with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings, or
- Matrix value of 4 and chroma of 1, with 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings (USDA Natural Resources Conservation Service 2006b).

Common (2 to less than 20 percent) to many (20 percent or more) redox concentrations (USDA Natural Resources Conservation Service 2002) are required in soils with matrix colors of 4/1, 4/2, and 5/2 (Figure A1). Redox concentrations include iron and manganese masses and pore linings (Vepraskas 1992). See “contrast” in this glossary for the definitions of “distinct” and “prominent.”

Table A1
Tabular key for contrast determinations using Munsell notation

Hues are the same (Δ h = 0)			*Hues differ by 2 (Δ h = 2)*		
Δ Value	**Δ Chroma**	**Contrast**	**Δ Value**	**Δ Chroma**	**Contrast**
0	≤1	Faint	0	0	Faint
0	2	Distinct	0	1	Distinct
0	3	Distinct	0	≥2	Prominent
0	≥4	Prominent	1	≤1	Distinct
1	≤1	Faint	1	≥2	Prominent
1	2	Distinct	≥2	---	Prominent
1	3	Distinct			
1	≥4	Prominent			
≤2	≤1	Faint			
≤2	2	Distinct			
≤2	3	Distinct			
≤2	≥4	Prominent			
3	≤1	Distinct			
3	2	Distinct			
3	3	Distinct			
3	≥4	Prominent			
≥4	---	Prominent			

Hues differ by 1 (Δ h = 1)			*Hues differ by 3 or more (Δ h ≥ 3)*		
Δ Value	**Δ Chroma**	**Contrast**	**Δ Value**	**Δ Chroma**	**Contrast**
0	≤1	Faint	Color contrast is prominent, except for low chroma and value.		Prominent
0	2	Distinct			
0	≥3	Prominent			
1	≤1	Faint			
1	2	Distinct			
1	≥3	Prominent			
2	≤1	Distinct			
2	2	Distinct			
2	≥3	Prominent			
≥3	---	Prominent			

Note: If both colors have values of ≤3 and chromas of ≤2, the color contrast is *Faint* (regardless of the difference in hue).
Adapted from USDA Natural Resources Conservation Service (2002)

Diapause. A period during which growth or development is suspended and physiological activity is diminished, as in certain aquatic invertebrates in response to drying of temporary wetlands.

Diatomaceous Earth. A limnic layer composed dominantly of skeletons of dead diatoms. If not previously dried, has a matrix color value of 3, 4, or 5, which changes irreversibly on drying as a result of the irreversible shrinkage of organic-matter coatings on diatoms. See USDA Natural Resources Conservation Service (1999) for complete definition.

Figure A1. Illustration of values and chromas that require 2 percent or more distinct or prominent redox concentrations and those that do not, for hue 10YR, to meet the definition of a depleted matrix. *Due to inaccurate color reproduction, do not use this page to determine soil colors in the field.* Background image from the Munsell Soil Color Charts reprinted courtesy of Munsell Color Services Lab, a part of X-Rite, Inc.

Distinct. See Contrast.

Fragmental soil material. Soil material that consists of 90 percent or more rock fragments; less than 10 percent of the soil consists of particles 2 mm or smaller (USDA Natural Resources Conservation Service 2006b).

Gleyed matrix. A gleyed matrix has one of the following combinations of hue, value, and chroma and the soil is not glauconitic (Figure A2):

- 10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value of 4 or more and chroma of 1; or
- 5G with value of 4 or more and chroma of 1 or 2; or
- N with value of 4 or more (USDA Natural Resources Conservation Service 2006b).

Figure A2. For hydric soil determinations, a gleyed matrix has the hues and chroma identified in this illustration with a value of 4 or more. *Due to inaccurate color reproduction, do not use this page to determine soil colors in the field.* Background image from the Munsell Soil Color Charts reprinted courtesy of Munsell Color Services Lab, a part of X-Rite, Inc.

Growing Season. In the Western Mountains, Valleys and Coast Region, growing season dates may be estimated by using WETS tables to determine the median dates of 28 °F (-2.2 °C) air temperatures in spring and fall based on long-term records gathered at the nearest appropriate National Weather Service meteorological station, or by one or both of the following on-site indicators of biological activity in a given year: (1) observations of growth or activity in vascular plants, or (2) soil temperature (see Chapter 4). Growing season determinations for wetland delineation purposes are subject to Corps of Engineers District approval.

High pH. pH of 7.9 or higher. Includes Moderately Alkaline, Strongly Alkaline, and Very Strongly Alkaline (USDA Natural Resources Conservation Service 2002).

Prominent. See Contrast.

Saturation. For wetland delineation purposes, a soil layer is saturated if virtually all pores between soil particles are filled with water (National Research Council 1995, Vepraskas and Sprecher 1997). This definition includes part of the capillary fringe above the water table (i.e., the tension-saturated zone) in which soil water content is approximately equal to that below the water table (Freeze and Cherry 1979).

Appendix B Point-Intercept Sampling Procedure for Determining Hydrophytic Vegetation

The following procedure for point-intercept sampling is an alternative to plot-based sampling methods to estimate the abundance of plant species in a community. The approach may be used with the approval of the appropriate Corps of Engineers District to evaluate vegetation as part of a wetland delineation. Advantages of point-intercept sampling include better quantification of plant species abundance and reduced bias compared with visual estimates of cover. The method is useful in communities with high species diversity, and in areas where vegetation is patchy or heterogeneous, making it difficult to identify representative locations for plot sampling. Disadvantages include the increased time required for sampling and the need for vegetation units large enough to permit the establishment of one or more transect lines within them. The approach also assumes that soil and hydrologic conditions are uniform across the area where transects are located. In particular, transects should not cross the wetland boundary. Point-intercept sampling is generally used with a transect-based prevalence index (see below) to determine whether vegetation is hydrophytic.

In point-intercept sampling, plant occurrence is determined at points located at fixed intervals along one or more transects established in random locations within the plant community or vegetation unit. If a transect is being used to sample the vegetation near a wetland boundary, the transect should be placed parallel to the boundary and should not cross either the wetland boundary or into other communities. Usually a measuring tape is laid on the ground and used for the transect line. Transect length depends upon the size and complexity of the plant community and may range from 100 to 300 ft (30 to 90 m) or more. Plant occurrence data are collected at fixed intervals along the line, for example every 2 ft (0.6 m). At each interval, a “hit” on a species is recorded if a vertical line at that point would intercept the stem or foliage of that species. Only one “hit” is recorded for a species at a point even if the same species would be intercepted more than once at that point. Vertical intercepts can be determined using a long pin or rod protruding into and through the various vegetation layers, a sighting device (e.g., for the canopy), or an imaginary vertical line. The total number of “hits” for each species along the transect is then determined. The result is a list of species and their frequencies of occurrence along the line (Mueller-Dombois and Ellenberg 1974, Tiner 1999). Species are then categorized by wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL), the total number of hits determined within each category, and the data used to calculate a transect-based prevalence index. The formula is similar to that given in Chapter 2 for the plot-based prevalence index (see Indicator 2), except that frequencies are used in place of cover estimates. The community is hydrophytic if the prevalence index is 3.0 or less. To be valid, more than 80 percent of “hits” on the transect must be of species that have been identified correctly and placed in an indicator category.

The transect-based prevalence index is calculated using the following formula:

$$PI = \frac{F_{OBL} + 2F_{FACW} + 3F_{FAC} + 4F_{FACU} + 5F_{UPL}}{F_{OBL} + F_{FACW} + F_{FAC} + F_{FACU} + F_{UPL}}$$

where:

PI	=	Prevalence index
F_{OBL}	=	Frequency of obligate (OBL) plant species;
F_{FACW}	=	Frequency of facultative wetland (FACW) plant species;
F_{FAC}	=	Frequency of facultative (FAC) plant species;
F_{FACU}	=	Frequency of facultative upland (FACU) plant species;
F_{UPL}	=	Frequency of upland (UPL) plant species.

Appendix C
Data Form

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region (DRAFT)

Project/Site: ____________________ City/County: ____________________ Sampling Date: __________

Applicant/Owner: ______________________________ State: ________ Sampling Point: __________

Investigator(s): ____________________ Section, Township, Range: ____________________

Landform (hillslope, terrace, etc.): ____________________ Local relief (concave, convex, none): ____________ Slope (%): ______

Subregion (LRR): ____________________ Lat: ______________ Long: ______________ Datum: ________

Soil Map Unit Name: ______________________________ NWI classification: ______________

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ______	No ______	**Is the Sampled Area within a Wetland?** **Yes ______ No ______**
Hydric Soil Present?	Yes ______	No ______	
Wetland Hydrology Present?	Yes ______	No ______	

Remarks:

VEGETATION

Tree Stratum (Use scientific names.)	Absolute % Cover	Dominant Species?	Indicator Status
1. ______			
2. ______			
3. ______			
4. ______			
Total Cover:	______		
Sapling/Shrub Stratum			
1. ______			
2. ______			
3. ______			
4. ______			
5. ______			
Total Cover:	______		
Herb Stratum			
1. ______			
2. ______			
3. ______			
4. ______			
5. ______			
6. ______			
7. ______			
8. ______			
Total Cover:	______		
Woody Vine Stratum			
1. ______			
2. ______			
Total Cover:	______		

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	______	x 1 =	______
FACW species	______	x 2 =	______
FAC species	______	x 3 =	______
FACU species	______	x 4 =	______
UPL species	______	x 5 =	______
Column Totals:	______ (A)		______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? **Yes ______ No ______**

Remarks:

SOIL

Sampling Point: ___________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. [2]Location: PL=Pore Lining, RC=Root Channel, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present.

Restrictive Layer (if present):

Type: ______________________________

Depth (inches): ______________________

Hydric Soil Present? **Yes** ______ **No** ______

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9) (**except NW coast**)
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**NW coast**)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ Frost-Heave Hummocks (D4)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches): ____________

Water Table Present? Yes _____ No _____ Depth (inches): ____________

Saturation Present? (includes capillary fringe) Yes _____ No _____ Depth (inches): ____________

Wetland Hydrology Present? **Yes** ______ **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: